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NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
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SHELTERS
  construction of, for civil defense,  21:8638
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  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
```

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23287        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 14520, 14525, 14569, 14793, 14820, 15141, and 15154.

14417 (AWRE-O-52/61) DETERMINATION OF TRITIUM IN THE RANGE 1μC TO 1C BY IONISATION CURRENT MEASUREMENTS. Ellis, P.; James, R. H.; Brown, F. (Atomic Weapons Research Establishment, Aldermaston (England)). [1961]. 12p. Dep. CFSTI. UK.

For the determination of the tritium content of tritium/hydrogen gas mixtures, quartz ionization chambers were found to give a linear relation between activity and ionization current over the range 1 μCi to 1 Ci. (auth) (UK)

14418 (CNEA-205) ANALISIS RAPIDO DE UNA MEZCLA DE ALGUNOS PRODUCTOS DE FISION. (Rapid Analysis of Some Fission-Product Mixtures). Agudo, E. Garcia (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1967. 19p. (In Spanish). Dep.

A combined method that is within the scope of any radiochemical laboratory possessing a multichannel spectrometer is described for the rapid analysis of fission product mixtures. The method is based on chemical separation by groups of some fission products that can be determined simultaneously by γ spectrometry. In the case of β emitters, the mixture is separated and measured by means of G-M tubes. (J.S.R.)

14419 (DP-1137) YIELDS OF TRANSCURIUM NUCLIDES IN THE SRP HIGH FLUX REACTOR. Holcomb, H. Perry (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Dec. 1967. Contract AT(07-2)-1. 11p. Dep. CFSTI.

Yields of the transcurium nuclides (through mass 255) produced in four $^{242}PuO_2$ targets that were irradiated in the Savannah River Plant high-flux reactor were measured by chemical analysis and radio-assay. Total integrated exposure of individual targets ranged from 3.8×10^{22} to 9.3×10^{22} n/cm^2. (auth)

14420 (K-1719) EFFECTS OF MATRIX GASES ON THE ALPHA IONIZATION GAS ANALYZER FOR URANIUM HEXAFLUORIDE. Pappas, W. S. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 15, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

The effects of matrix gas composition on the alpha ionization gas analyzer for trace uranium hexafluoride determination were examined. Theoretical and experimental studies led to a simple technique for calibrating the analyzer in any gas system when its sensitivity in a single gas is known. The instrument was applied to measure trace uranium hexafluoride in C_6F_{12} (perfluorodimethylcyclohexane) at pressures much lower than is permissible in nitrogen or air systems. (auth)

14421 (LA-3843) SPECTROPHOTOMETRIC DETERMINATION OF VANADIUM IN PLUTONIUM-VANADIUM ALLOYS. Baughman, W. J.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Jan. 2, 1968. Contract W-7405-eng-36. 9p. Dep. CFSTI.

Vanadium, when present in concentrations between 120 ppM and 5% in plutonium-vanadium alloys, is measured spectrophotometrically as the vanadium(V)-N-benzoyl-N-phenylhydroxylamine (BPHA) complex following separation from 100 mg of plutonium by extraction of the complex into chloroform. The vanadium and plutonium are oxidized to their (V) and (VI) oxidation states, respectively, with fuming perchloric acid. The vanadium(V) is extracted from 2.8 to 4.2M hydrochloric acid into chloroform containing BPHA, and the absorbance of the organic phase is measured at a wavelength of 530 mμ. At this wavelength, the molar absorptivity of the vanadium-BPHA complex is 4,260. Based on 14 determinations each of 12, 30, 60, 120, and 225 μg (120, 300, 600, 1200, and 2250 ppM) of vanadium, the relative standard deviations of the method are 3.5, 2.3, 1.7, 1.2, and 0.9%, respectively. Of 58 ions tested, 26 interfere when present in 100-mg quantities; at the 1-mg level, only Cr^{3+}, Mn^{2+}, Nb^{5+}, Pt^{2+}, Sn^{4+}, Ta^{5+}, Ti^{3+}, and WO_4^{2-} interfere. (auth)

14422 (NLCO-1004) DETERMINATION OF FLUORIDE IN THORIUM SOLUTIONS. Bohlander, R. F. (National Lead Co. of Ohio, Cincinnati). Sept. 18, 1967. Contract AT(30-1)-1156. 14p. (CONF-671052-1; CONF-671012-4). Dep. CFSTI.

From National Lead Analytical and Physical Testing Symposium, Niagara Falls, N. Y.

From 11th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A method was developed for determination of micro concentrations of fluoride in acid solutions of thorium nitrate. The determination can be performed in 30 minutes. The fluoride could be successfully and quickly distilled from 15M phosphoric acid using a modified version of the Willard-Winter still. Thorium does not precipitate if the solution is left strongly acid. Following the distillation, micro quantities of fluoride were measured spectrophotometrically, employing the eriochrome cyanine R-zirconium lake. The results showed a high degree of precision. (auth)

14423 (NLCO-1006) ADAPTATION OF GAS CHROMATOGRAPHY TO THE IDENTIFICATION AND ESTIMATION OF RESIDUAL GASES IN HIGH-FIRED THORIUM OXIDE. Ellis, W. G. (National Lead Co. of Ohio, Cincinnati). Sept. 15, 1967. Contract AT(30-1)-1156. 14p. (CONF-671012-5). Dep. CFSTI.

From 11th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A gas chromatograph was adapted for use in identification and estimation of residual gases in high-fired thorium oxide. A number of gases were identified by this means including water vapor, carbon monoxide, carbon dioxide, hydrogen sulfide, sulfur dioxide, and sulfur trioxide. Quantitative determination of the sulfur compounds was not achieved because of their incomplete dissociation at the temperatures available. This technique was successfully applied to the simultaneous determination of 10 to 100 ppM of water and carbon dioxide in thorium oxide. In this method the sample was heated to 950°C in a tube furnace. The evolved gases are concentrated by sweeping the ignition products into a precolumn packed with Porapak S, which is cooled in liquid nitrogen. At the end of the ignition period the products condensed in the precolumn are volatilized by heating and analyzed in a gas chromatograph using a thermal conductivity detector. Porapak S was satisfactory as the stationary phase in the chromatographic column. (auth)

14424 (ORNL-4196) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1967. Raaen, Helen P. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 171p. Dep. CFSTI.

Research progress is reported in 12 sections: analytical instrumentation, effects of radiation on analytical methods, analytical chemistry for reactor projects, special research and

development activities, analytical biochemistry, x-ray and optical spectrochemistry, mass spectrometry, optical and electron microscopy, nuclear and radiochemical analyses, inorganic preparations, and organic preparations. Service analyses, work on the ORNL Master Analytical Manual, activities related to educational institutions, and extralaboratory professional activities are discussed. A separate abstract was prepared for each of the 12 sections. (M.C.G.)

For abstracts of individual sections see: 14425–14434, 14482, and 14483.

14425 (ORNL–4196, pp 1-12) ANALYTICAL INSTRUMENTATION. Fisher, D. J.; Stelzner, R. W. (Oak Ridge National Lab., Tenn.).

The prototype of the controlled-potential controlled-current cyclic voltammeter was used for obtaining analytical and mechanistic data in molten-salt media. Satisfactory results were obtained, although interference from nearby rf sources caused difficulties. A duplicate instrument is performing satisfactorily in room-temperature experiments with aqueous and nonaqueous solvent systems. A dual set-point voltage comparator (ORNL model Q-2950) was designed. It is needed to calibrate accurately the scan rates used in the controlled-potential controlled-current voltammeter, which range from 0.005 to 500 v/sec. A modular, solid-state, controlled-potential coulometric titrator is being designed. A simple modification to the circuit of the ORNL model Q-2564 high-sensitivity controlled-potential coulometric titrator improves the stability of the instrument and eliminates amplifier limiting that otherwise can occur. Several additions and revisions were made to the circuit of the prototype of the controlled-potential dc polarograph-voltammeter (ORNL model Q-2792) that improve its performance. An apparatus (ORNL Q-2942) was developed for the precise electromechanical control of the drop time (t) of a polarographic dropping-mercury electrode and its performance was evaluated. The t achieved with this apparatus is independent of sample constituents, capillary characteristics, and electrode potential; a short t can be obtained with a low flow rate of mercury and negligible convective disturbance to the current. A study of the long-term precision attainable in single-cell first-derivative dc polarography is under way. By control of temperature, drop time, mercury head, sparging, and instrument stability, a short-term S = 0.03% can be achieved, but long-term S ≅ 1%. It is planned to investigate the utility of controlling directly the average mercury flow rate as a means to improve the long-term precision of this polarographic method. An analog time integrator was fabricated. It has been used to calibrate a light-beam splitter that will be used in turn to calibrate photographic emulsions. A current amplifier was built; it has a calculated maximum error of ±0.1%. An automatic output sampler was designed for obtaining samples from the output of a continuous-flow analyzer and for transferring the samples to filter-paper disks. The electronics unit of a model VI flame spectrophotometer was redesigned to improve its performance and reliability; the model VI-A instrument is in use for remotely controlled determinations. The electronics units of two modified model Q-1887 flame spectrophotometers were also redesigned (model VI-B). A complete model VI-C flame spectrophotometer is being designed. The ultimate sensitivity with which a signal can be measured in the inevitable presence of noise depends on the signal-to-noise ratio, S/N. If the noise that accompanies the signal is random and if a large number of repeated measurements can be made and summed in register with respect to the signal, the S/N of the processed data is increased relative to that of a single measurement in proportion to the square root of the number of measurements. It was shown that the sensitivity of measurement with a flame photometer is increased substantially by use of a signal-averaging computer to enhance S/N. (M.C.G.)

14426 (ORNL–4196, pp 12-15) EFFECTS OF RADIATION ON ANALYTICAL METHODS. Kubota, Hisashi; Zittel, H. E. (Oak Ridge National Lab., Tenn.).

The effects of radiation on various analytical methods and reagents were studied further. New methods or conditions to minimize the deleterious effects of radiation were evaluated. A voltametric method for microamounts of fluoride was developed. It is based on the reaction of fluoride with the zirconium–alizarin red S complex and the anodic reactions of alizarin red S at the rotating pyrolytic-graphite electrode. For the separation of fluoride, a rapid distillation usable in hot cells was developed. Fluoride is distilled as fluosilicic acid, which is then measured spectrophotometrically as the alizarin complexone. The chromophore is radiation sensitive; its absorbance decreases 1% per 1000-rad dose of gamma radiation from ^{60}Co. The uranium thiocyanate complex used in the spectrophotometric determination of uranium proved to be radiation sensitive. Optimum conditions for using the method under radiation were established. A study was begun of the effects of radiation on various radiation-safeguard spray solutions. Solutions of thiosulfate were investigated. In this connection, the anodic reactions of thiosulfate at the rotating graphite electrode were determined in an effort to establish a highly sensitive, rapid, and selective voltametric method for following the effect of gamma radiation on thiosulfate. Thiosulfate has anodic waves at ~ +0.8 and ~ +1.1 v vs S.C.E. whose heights are proportional to thiosulfate concentration. The +0.8-v wave results from the oxidation of thiosulfate to tetrathionate, the +1.1-v wave from oxidation of tetrathionate. These findings indicate that a voltametric method for thiosulfate is feasible. It was found possible to use radiolytically generated reagents from homogeneous separations. With chloral hydrate as a source of radiolytically produced chloride and acid, silver was precipitated as the chloride and barium as the sulfate. The use of radiolytic reactions offers a fresh approach to the study of nucleation processes. Studies were made to determine the effects of the radiation from the radioactive wastes on water and other materials present in natural salt (NaCl). Hydrochloric acid was found to be a by-product of the storage of highly radioactive wastes in salt formations. The hydrolysis of iron chloride in shale, which is an impurity in natural salt, releases HCl. Irradiation of solid NaCl caused no measurable release of chlorine at elevated temperatures. The release of an unidentified oxidant thought to be an organic peroxide was observed at the demonstration site. (auth)

14427 (ORNL–4196, pp 15-32) ANALYTICAL CHEMISTRY FOR REACTOR PROJECTS. Meyer, A. S.; Dale, J. M. (Oak Ridge National Lab., Tenn.).

The determination of oxide in highly radioactive MSRE fuel samples was continued. Oxide concentrations of several samples from the second ORR molten-salt loop were also determined. A method was developed for the determination of U^{3+} in radioactive fuel by hydrogen reduction. Oxidized species in molten fuel salt samples are reduced by sparging the samples with hydrogen. The rate of production of HF is a function of the ratio of the oxidized to reduced species in the melt. A computer program was developed to calculate the expected HF yields for any melt composition. The fuel samples run to date do not reflect the beryllium additions made to reduce the reactor fuel, a fact possibly accountable for by an interference stemming from the radiolytic generation of fluorine in the fuel samples. A method is being developed for the remote measurement of ppM concentrations of HF in helium or hydrogen gas streams. The effects of BF_3 on MSRE pump oil were studied. Measurements were made of increases in hydrocarbon concentrations of an He–BF_3 gas stream after contact with the oil. Development studies are being made on the design of a gas chromatograph to be used for the continuous determination of sub-ppM and ppM concentrations of permanent-gas impurities and water in the helium blanket gas of the MSRE. This problem of analyzing radioactive gas samples prompted the design and construction of an all-metal six-way pneumatically actuated diaphragm valve. Design work was continued on the experimental molten-salt test loop. Measurements of the potentials of the Ni/Ni^{2+} couple in molten fluoride salts indicated that this couple may be useful as a reference electrode for fluoride melts. Controlled-potential, voltametric, and chronopotentiometric studies were carried out on the reduction of U(IV) in molten fluoride salts. It was concluded that the U(IV) → U(III) reduction in molten $LiF–BeF_2–ZrF_4$ is a reversible one-electron process. Spectrophotometric evidence showed that $2LiF–BeF_2$ is compatible with SiO_2 in a system that contains excess SiF_4 at temperatures up to ~1000°K. The ability to contain $2LiF–BeF_2$ melts in silica cells permitted more precise measurement of the molar absorptivities of U(IV) than was possible with windowless cells. Studies of the solubility of Cr(III) in $2LiF–BeF_2$ at 550°C were also made in silica cells. An investigation of the spectra of U(VI) in molten fluoride salts was initiated. The simultaneous electrochemical generation and spectrophotometric observation of species in molten fluorides was demonstrated experimentally. Reduction of U(IV) and reoxidation of U(III) was observed with this system. In the production of UO_2 microspheres by the Sol-Gel Process, an important step is the removal of carbonaceous impurities by treatment with steam. A system was designed and constructed to continuously sample and determine the hydrocarbon content of the steam from tests on this procedure. The system was used to monitor the hydrocarbon content of steam from the decarbonation of various UO_2 samples as a function of temperature and time. An in-line method was needed to monitor the concentrations of the reagent reduction products, BrF_3 and Br_2, in the effluent from the Fluidized-Bed Volatility Pilot Plant. Some success was realized with a gas chromatographic technique. Elution times were determined for BrF_3, BrF_5, Br_2, and UF_6. The design of an analytical system for in-line analysis of gases generated by in-pile tests of fuel elements was changed to incorporate a quadrupole residual-gas analyzer. This will permit the measurement of more components

over greater ranges of concentrations and at an acceptable analysis frequency. A CO infrared analyzer was installed in the gas-sampling hood at the ORR and calibrated. The program was continued on gas-chromatographic determination of volatile organic air pollutants that are most likely to form volatile organic iodides with fission product iodine. (M.C.G.)

14428 (ORNL–4196, pp 33–44) SPECIAL RESEARCH AND DEVELOPMENT ACTIVITIES. Thomason, P. F.; Shults, W. D.; Meyer, A. S.; Dale, J. M. (Oak Ridge National Lab., Tenn.).

For gas chromatography a new preparative gas chromatograph was acquired. The major factor in obtaining ultrapure compounds is the proximity of the elution peaks of the impurities to the peak of the parent compound. A modification of the chromatograph developed at ORNL allows different cut points to be selected on each side of the parent peak and provides the possibility of producing compounds of 99.99% purity. A method was developed for the gas chromatographic determination of ppM concentrations of sulfur hexafluoride in methane. The results from triplicate samples show a deviation from the mean of ±5%. A pyrolysis–gas-chromatographic technique was used to determine the volatile organic substances in a mold-release compound and in aluminum powder. Precise procedures were developed for resolving complex mixtures of constituents of tRNA by thin-layer chromatography on PEI-cellulose. The tRNA constituents in alkaline hydrolysates of E. coli B and of yeast were isolated and identified. A method was perfected to separate and identify the mushroom toxins α-, β-, and γ-amanitin. The efficiency of fermentation processes for the production of the toxins in quantity was determined. The cross-linked dextran Sephadex G-75 Superfine Gel was evaluated for the thin-layer chromatographic separation of proteins according to molecular weight. In electroanalytical studies a vertical-orifice rapid Teflon dropping-mercury electrode was shown to be suitable for rapidly obtaining reproducible and theoretically correct polarograms when the solution polarographed contained polyacrylamide to suppress maxima. A 1M hydroxylamine hydrochloride solution was found to be a suitable supporting medium for the polarographic determination of U(VI) in the presence of Cu(II), because the half-wave potentials are separated by ~270 mv. Studies of ion-specific electrodes revealed that an optimum pH range exists for each electrode. Different makes of calcium, divalent, fluoride, and nitrate ion-specific electrodes were evaluated. A Beckman IR-12 infrared spectrophotometer was put into operation, and many organic and inorganic materials were examined with it. A nuclear magnetic resonance spectrometer was used to elucidate the chemical structure and configuration of a number of organic compounds. A variety of special work included the polarographic determination of W in W–Re thermocouple wire; study of arsenazo as a chromogenic reagent for plutonium; development of fluorometric methods for phosphate with aluminum-morin and tin-flavonol systems; sealed-tube dissolution of uranium nitride; pyrohydrolysis of fluoride-containing materials by use of quartz or platinum combustion tubes; determination of periodate, iodate, and iodide in mixtures of the three; density-gradient determination of the density of pyrolytic carbon particles; and study of the autodecomposition of bromate in acid nitrate media. A Cary model 14 spectrophotometer is being fitted with a glove box to permit spectrophotometric studies of highly radioactive alpha-emitting substances. Also, a Leco Nitrox-6 Analyzer was installed in a glove box in the High-Radiation Analytical Facility (HRAF) to determine oxide-to-metal ratios of alpha-emitting metal oxides. The effect of salt content on the absorbance of solutions of tRNA's was studied. (auth)

14429 (ORNL–4196, pp 44–54) ANALYTICAL BIOCHEMISTRY. Goldstein, Gerald (Oak Ridge National Lab., Tenn.).

In the analysis of transfer ribonucleic acids (tRNA's), the optimum conditions for the assay of valine- as well as leucine- and phenylalanine-accepting tRNA's were established. Techniques for the isolation of aminoacyl synthetase enzymes were examined, and an improved enzyme preparation of higher purity and specific activity was prepared. As part of a continuing effort to improve the analysis, various disk pretreatments were tested. The assay procedure was automated; 40 samples per hour can be analyzed with precision and accuracy not significantly different from those of manual assays. Studies of the separation of nucleic acid components by ligand-exchange chromatography were continued, and this technique is now used routinely to determine terminal nucleoside, base ratio, and molecular weight. Ultraviolet-absorbing components isolated from urine by anion-exchange chromatography are being collected for characterization by infrared, nuclear magnetic resonance, and mass spectrometry. Because only a very small quantity of many of these compounds will be available, other techniques such as the use of ^{14}C-labeled compounds and preconcentration by gel-permeation chromatography are also being applied. Attempts are being made to isolate and characterize antigen activity in virally induced tumors. Gel electrophoresis, both analytical and preparative, is used extensively. A new method, centriphoresis, in which proteins migrate through a density gradient in both electrical and centrifugal fields, is now being used, and antigen activity was concentrated. The amino acid content of various normal tissues and of tumorous tissue was measured to determine whether significant differences exist. Urine samples from normal persons and from patients with various pathological conditions were also analyzed. At present the results of both these studies are inconclusive. The bulk of the amino acid analytical work is now concerned with sequence analysis of proteins. The sequence of the β chain of mouse hemoglobin was partially determined. (auth)

14430 (ORNL–4196, pp 55–9) X-RAY AND OPTICAL SPECTROCHEMISTRY. Feldman, Cyrus (Oak Ridge National Lab., Tenn.).

Computer subroutines were written to calculate and to plot chemical compositions from electron-probe data by use of fundamental physical data stored on tape. A beam splitter was designed and tested for use in calibrating spectrographic emulsions. To facilitate the chemical collection of impurities in bone ash, phosphate was removed by electrodialysis through anion-permeable membranes; a similar method is being used to prepare ultrapure reagents. Commercial freeze-dried foods are being evaluated as possible standards for the interlaboratory-check analysis of tissue. The limits of sensitivity for the determination of rare earths in $LiF-BeF_2$ type nuclear fuel and of numerous trace elements in $^{233}UO_2-ThO_2$ were extended by combining preconcentration procedures with arc spectrographic analysis. (auth)

14431 (ORNL–4196, pp 59–62) MASS SPECTROMETRY. (Oak Ridge National Lab., Tenn.).

Work with the MS-7 spark-source mass spectrograph increased 30%. Unusual alloys and metallic samples made from separated stable isotopes were analyzed for trace constituents. The spark-source technique for analysis of solutions was shown to be satisfactory for determining Nb in ^{231}Pa and for studying the penetration of irradiated graphite by constituents of MSRE salts. A single-magnetic-stage mass spectrometer was constructed and put into use for analysis of organic compounds. A wide variety of samples of mass up to 600 were analyzed satisfactorily. The first ionization potentials of the lanthanides were measured by the surface-ionization comparison technique. A mass spectrometric search was made for neon in minerals and in volcanic glasses. The analyses are important in distinguishing between primordial and radiogenic components and their role in the origin of the atmosphere and its relationship to the origin of the solar system and the genesis of elements. A high-resolution double-focusing mass spectrometer was assembled and tested. It has a resolution of 4000 and accepts solid and gaseous inorganic samples. (auth)

14432 (ORNL–4196, pp 63–6) OPTICAL AND ELECTRON MICROSCOPY. Willmarth, T. E.; Harmon, T. G.; Wright, H. W. (Oak Ridge National Lab., Tenn.).

Optical and electron microscopy and diffraction studies were made on a wide variety of materials. Four typical studies involving fundamental and applied chemistry, metallurgy, and nuclear safety are discussed briefly. The examination of highly radioactive materials in the form of prepared particles, corrosion products, and replica-stripped material was continued at the electron microscopy facility. This work is illustrated by an electron micrograph of particulate $^{238}PuO_2$. Several instruments were installed; among them are a dark-field device for the Philips EM 200 electron microscope and a precision plate developer for electron-microscope plates. (auth)

14433 (ORNL–4196, pp 66–89) NUCLEAR AND RADIOCHEMICAL ANALYSES. Lyon, W. S.; Ross, H. H. (Oak Ridge National Lab., Tenn.).

Gamma branching in ^{95}Zr and cross sections for production of ^{113}Sn and ^{250}Bk by neutron capture were measured. Alpha decay of the isotope ^{154}Ho was studied, and standardization of ^{197}Hg was firmed through interlaboratory comparisons. A film-recording radiation-event monitor for pulsed x and gamma radiation was developed, the use of the beta-excited isotopic-light-source photometer was extended to the ultraviolet region, and a semiconductor x-ray emission spectrometer that has an isotopic x-ray source was investigated. The development of radiation-stimulated light sources continued. Improvements to and computer applications in analytical alpha spectrometry were made. New facilities were studied, proposed, or commenced; these include a facility for activation analysis with a ^{252}Cf source, a high-intensity analytical cyclotron, an activation analysis laboratory at the HFIR, target assemblies and pneumatic transfer for photon and fast-neutron activation at the ORELA, possibility of using the 86-in. cyclotron as a neutron source, and a prototype low-level radiation counting laboratory for the Lunar Receiving Laboratory in Houston. Work continued on interactions of ^3He particles with selected low-Z

elements, and a method to calculate sensitivities, interferences, and optimum bombardment energies was developed. The recoil technique was evaluated as an aid in activation-analysis nuclide identification. A number of applied activation analysis problems were solved. A 14-MeV neutron generator facility for determining oxygen in alkali metals was completed. Fluorine was determined in fluorspar ores, and a dual-axis sample rotator was developed to assist in this and other problems that require high precision. Development of the leached fuel element monitor was completed. High-energy gamma rays in ^{233}U, ^{239}Pu, and ^{241}Am were studied, the half-lives of a number of radionuclides were redetermined, and a radiochemical study was made of the HFIR cooling water. Attempts are under way to use radioisotopic tagging as an aid in locating stolen copper wire. New separation methods reported include: californium from curium and berkelium from cerium by extraction chromatography, americium by liquid-liquid extraction, berkelium(IV) from cerium(IV) by anion exchange, and liquid-liquid extraction of niobium with TTA. Pure $^{245,246}Pu$ was prepared; evidence for photofission of iron was reported. A method to improve liquid-scintillation counting in aqueous systems was developed. Water research was broadened to include assistance in testing of desalination plants, ecological investigations of local watersheds, application of tracers and activation analysis in tracing the flow of rivers and streams, and removal of sodium from activated samples. In the transuranium research program a laboratory was equipped for special analytical service, a number of lanthanide and actinide β-diketones were prepared, controlled-potential coulometric titration of americium was reported, and the feasibility of determining the formal potential of the Bk(III)-Bk(IV) couple was studied. (auth)

14434 (ORNL-4196, pp 93-8) PART B. SERVICE ANALYSIS. (Oak Ridge National Lab., Tenn.).

Work in mass spectrometry, spectrochemistry, and process analyses laboratories is reported. Isotopic abundances of samples from irradiated HFIR components were determined; purity of compressed gases was certified; an electron bombardment source that uses a five-sample wheel was developed and tested for use with the 12-in. 90° mass spectrometer; and the isotopic analysis of all elements from thorium through californium was done routinely in the mass spectrometric laboratory. Trace impurities were determined in the stable isotopes of 45 elements in the spectrochemistry laboratory; and large samples of air, water, metals, and unusual alloys were analyzed. In the process laboratories californium and einsteinium were determined in solutions, fluoride was isolated by pyrohydrolysis and measured spectrophotometrically, isotopic dilution and mass spectrometry were used to measure extremely low levels of plutonium, and the development on a new vacuum-fusion gas chromatographic analyzer was completed. (D.H.M.)

14435 (EURFNR-365) THORIUM AND URANIUM DETERMINATION BY ROENTGENOFLUORESCENCE ANALYSIS. Ertel, D.; Wettstein, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-560. 29p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

This report was previously abstracted from the original language as NSA 22: 1952. (E.J.H.)

14436 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN ORGANIC SOLUTIONS OF TRIBUTYL PHOSPHATE. Obrenovic-Paligoric, I.; Gal, I. J.; Vajgand, V. (Boris Kidrich Inst. of Nuclear Science, Belgrade. Univ. of Belgrade). Anal. Chim. Acta, 40: 534-7(Mar. 1968).

A spectrophotometric method for direct determination of uranium in TBP is described. The chromogenic reagent is added as a toluene solution. The sensitivity of the method makes it possible to take very small aliquots. It is convenient for determination of 0.05 to 9 g of uranium per liter of TBP solvent. The standard error is below ±5%. (M.C.G.)

14437 VOLTAMETRIC DETERMINATION OF CERIUM IN CONCENTRATED PHOSPHORIC ACID. Lapid, Y.; Bazini, E.; Gottesfeld, S. (Atomic Energy Commission, Negev, Israel). Anal. Chim. Acta, 40: 526-30(Mar. 1968).

To determine cerium in strong acid media and in the concentration range from 10^{-4} to 10^{-3} M, a rapid voltametric analysis with a rotating platinum electrode as the indicator electrode, was applied. Cerium is determined by measuring its limiting oxidation current at a fixed potential. (M.C.G.)

14438 DETERMINING IMPURITIES IN FERRITE GARNETS AND IN YTTRIUM OXIDE BY ACTIVATION ANALYSIS. Dutov, A. G.; Lobanov, E. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 82-3 (1967). (In Russian).

Monocrystalline ferrites made from Y_2O_3 have a variable resonance width depending on the impurity content of Tb, Dy, Ho, Sm, and Gd. Samples of garnet (10 to 20 mg) were irradiated at a neutron flux of 1.2×10^{12} n cm^{-2} sec^{-1}, and were examined on a NaI gamma scintillation spectrometer having 100 channels. Because of the strong bremsstrahlung background radiation the irradiated sample was allowed to decay for 10 half-lives of ^{90}Y. An analysis of the gamma spectrum gave the following content of impurities in the sample: 7.2×10^{-2}% Gd, 3.3×10^{-3}% Tb, and 4.2×10^{-4}% Eu. The iridium content in the samples varied from 6.5×10^{-5} to 6.0×10^{-4}%. By increasing the irradiation time a factor of 5 and the mass a factor of 10, the following sensitivities can be attained: 10^{-5}% Gd, 10^{-7}% Tb, 10^{-5}% Eu, and 10^{-8}% Ir. The error is less than 7%. The contents of Cl, Dy, and Mn were found to be 1.3×10^{-2}%, 5.6×10^{-3}% and 7.3×10^{-4}%, respectively. (TTT)

14439 PRECISE, NON-DESTRUCTIVE DETERMINATION OF FLUORINE BY 14-MeV NEUTRON ACTIVATION ANALYSIS. England, E. A. M.; Hornsby, J. B.; Jones, W. T.; Terrey, D. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Anal. Chim. Acta, 40: 365-71(Mar. 1968).

A procedure is described for the precise determination of fluorine in organic and metal-organic compounds by 14-MeV neutron activation analysis using the reaction: $^{19}F(n,2n)^{18}F$ (β^+, $t_{\frac{1}{2}}$ = 110 min). A relative standard deviation of better than ±0.5% was achieved by irradiating samples and standard simultaneously. Uniform neutron exposures were ensured by rotating the samples during irradiation. Positron emitters of short half-life were allowed to decay before counting. In metal-organic compounds, Sc, Zn, Ga, and Ag caused the most serious interference; for organic compounds the method was rapid, and specific for fluorine. (auth)

14440 DETERMINATION OF RHENIUM IN MOLYBDENITES BY NEUTRON ACTIVATION ANALYSIS. Boyadjov, Iv.; De Neve, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 40: 373-8 (Mar. 1968).

A thermal neutron activation method for determination of rhenium in molybdenites is described. The rhenium was separated from the matrix after irradiation by pyridine extraction from 4 N sodium hydroxide solution; γ and β spectrometry are applicable. For a neutron flux of 4×10^{11} n/cm^2 sec, an irradiation of 2 hr and a sample of ca. 50 mg, β-counting allows determinations in the ppB range. (auth)

14441 NON-DESTRUCTIVE ACTIVATION ANALYSIS OF TRACE IMPURITIES IN GERMANIUM. De Neve, R.; De Soete, D.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 40: 379-86 (Mar. 1968).

A non-destructive activation analysis of trace impurities in germanium giving rise to long-lived γ-emitting isotopes is described. Hg, Sn, Cr, Sb, Sc, Zn, and Co were determined by γ spectrometry after irradiation with thermal neutrons (ϕ_{th} = 10^{14} n.cm^{-2}.sec^{-1}, irrad. time: 15 h, cooling period: ca. 30 days). The complex γ spectrum was analyzed by a combination of Covell's method and matrix calculus. The detection limits are approximately 2 ppB of Hg, 7 ppB of Cr, 200 ppB of Sn, 1 ppB of Sb, 10 ppB of Zn, 0.2 ppB of Co and 0.1 ppB of Sc. (auth)

14442 CHELATING RESINS FOR THE CONCENTRATION OF TRACE ELEMENTS FROM SEA WATER AND THEIR ANALYTICAL USE IN CONJUNCTION WITH ATOMIC ABSORPTION SPECTROPHOTOMETRY. Riley, J. P.; Taylor, D. (Univ. of Liverpool). Anal. Chim. Acta, 40: 479-84(Mar. 1968).

An investigation was made of the uptake of trace elements from both distilled water and sea water by the chelating ion-exchange resins Chelex-100 and Permutit S1005. The resins retained the following elements with an efficiency of ca. 100%: Ag, Bi, Cd, Cu, In, Pb, Mo, Ni, rare earths, Re (90% only), Sc, Th, W, V, Y, and Zn. Manganese was retained quantitatively only by the Chelex resin. The following elements are removed with 100% efficiency by means of 2 N mineral acids: Bi, Cd, Co, Cu, In, Ni, Pb, rare earths, Sc, Th, Y, and Zn. Ammonia (4 N) completely removes Mo, W, V, and Re. The resins were used in conjunction with atomic absorption spectrophotometry for the simultaneous determination of Zn, Cd, Cu, Ni, and Co in sea waters. (auth)

14443 ISOTOPIC ANALYSIS OF NITROGEN WITH LOW ^{15}N CONTENT BY OPTICAL SPECTROMETRY. Leicknam, J. P.; Middelboe, V.; Proksch, G. (Agence Internationale de l'Energie Atomique, Niederoesterreich, Austria). Anal. Chim. Acta, 40: 487-502(Mar. 1968). (In French).

For mixtures of $^{14}N_2$ and $^{14}N^{15}N$ low in ^{15}N (isotopic abundances less than 2%), previous optical spectrometric methods do not produce rapid results of sufficient precision. Operating conditions are described for the determination of the isotopic content

to ± 1% when the sample contains an atom ratio of $^{15}N:^{14}N$ of 1.5:100. The time required for a determination was ca. 10 min. A spectrometer was modified by the substitution of an exit slit and a photomultiplier in place of a photographic plate. The excitation of the electrodeless discharge tube was made by a high-frequency field. The method was applied to samples of ammonium salts, fertilizers, and plant material. In all cases, the precision of the isotopic measurements was greater than that required for most agricultural studies (5 to 6%). (auth)

14444 ACTIVATION ANALYSIS OF BROMINE, IODINE, AND ARSENIC IN OILS FROM FISHES, WHALES, PHYTO- AND ZOOPLANKTON OF MARINE AND LIMNETIC BIOTOPES. **Lunde, Gulbrand (Central Inst. for Industrial Research, Oslo). Int. Rev. Gesam. Hydrobiol., 52: 265-79(1967).**

A method for analysing Br, I, and As in oils from marine and limnetic organisms was developed. It was based on neutron activation of the oils and the measurement of the induced radioactivity by a γ spectrometer without prior chemical treatment of the oils. About 0.5 g of each oil was used for determination of all three elements. The lower limit was about 25 mg of oil for each determination, because of the sensitivity of the method and difficulties in handling the oil samples of this size. The oils sealed into polyethylene ampoules were irradiated in the nuclear reactor JEEP I, Kjeller, Norway. The neutron flux was about 2×10^{12} n cm^{-2} sec^{-1}. The irradiation time was from 1 to 2 hr when all three elements were determined. A 400-channel γ spectrometer was used to record the induced radioactivity in the oils. Due to the short half-life of ^{128}I ($T_{\frac{1}{2}}$ = 25 min) it was necessary to begin measurements within 1 to 2 hr after irradiation. After 4 to 5 hr this radioactivity from Br and As could be determined. Bromine-82 and ^{76}As both had γ peaks at 0.55 MeV and therefore were superimposed in the γ spectrum. However, ^{82}Br had γ energies of 0.78 and 1.04 MeV which could be used for quantitative determination. If the measurements were made within a day after the activation, there would be some contribution of 0.51 MeV and 0.62 MeV γ rays from ^{80m}Br. Bromine-80m had a half-life of 4.4 hr and disintegrated to ^{80}Br with a half-life of 18 min. The 0.78 MeV γ peak of ^{82}Br was used for the determination of the Br. Arsenic was determined by using the 0.55 MeV γ peak from ^{76}As after the contribution from ^{82}Br in the 0.55 MeV γ peak was subtracted. (BBB)

14445 AUTORADIOGRAPHIC METHOD FOR QUANTITATIVE MEASUREMENTS OF α-RADIOACTIVE ISOTOPES. **Korobkov, V. I.; Zaborenko, K. B. Radiokhimiya, 9: 522-3(1967). In Russian).**

The concentration, C_2, of an alpha-emitting radioisotope present in a solution is related to the concentration, C_1, of that isotope in a photoemulsion film immersed in the solution by the formula $K = C_1/C_2$. More sophisticated formulas for determining the needed values, including the emulsion area, atomic weight, etc., are given. These formulas are particularly useful where the amount of radioisotope involved is very small. (TTT)

14446 QUANTITATIVE SPECTROGRAPHIC DETERMINATION OF HAFNIUM IN TUNGSTEN BY A VACUUM-CUP SOLUTION METHOD. **Peck, Edgar S. (Univ. of California, Livermore). Anal. Chem., 40: 324-7(Feb. 1968). (UCRL-70613).**

A spectrographic technique employing the vacuum-cup electrode for the quantitative determination of Hf in W following acid dissolution is described. No chemical separation is required, and metallic samples in any form may be analyzed. Citric acid serves as a complexing agent. Sample preparation is rapid and simple. Zr does not interfere. The analytical range is 0.05 to 11.1% Hf in W. The relative standard deviation is about 5%. (auth)

14447 ISOTOPIC DETERMINATION OF ^{43}Ca AND ^{41}Ca BY NEUTRON TIME-OF-FLIGHT SPECTROMETRY. **McMurray, W. Roy; Peisach, Max; Pretorius, Rene; van der Merwe, Philip; van Heerden, Izak J. (Southern Universities Nuclear Inst., Faure, South Africa). Anal. Chem., 40: 266-70(Feb. 1968).**

Neutron time-of-flight spectrometry was used to determine the isotopic concentration of ^{43}Ca and ^{48}Ca in CaF_2 targets irradiated with a pulsed proton beam of 4.5 MeV. For determination of ^{43}Ca, neutron counts from ^{48}Ca were used as an internal standard to represent total Ca, and vice versa for the determination of ^{48}Ca. ^{43}Ca was determined over the range 0.145(natural) to about 2 at. % and ^{48}Ca over the range 0.18(natural) to about 1.2 at. % with relative standard deviations of ±4.3 and ±5.6%, respectively. The duration of an analysis was between 30 and 60 min. The method can be extended to determine higher enrichments of either isotope. The effects of proton energy, measuring angle, and target thickness were investigated. (auth)

14448 DETERMINATION OF FREE ACID BY AUTOMATED ION EXCHANGE-COLORIMETRY. **Gaddy, R. H.; Dorsett, R. S. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT (07-2)-1. Anal. Chem., 40: 429-32(Feb. 1968). (DP-MS-67-79).**

An automated method is described for determining free acid in both HNO_3 and HCl systems containing hydrolyzable ions such as La^{3+}, Al^{3+}, Th^{4+}, and UO_2^{2+}. The hydrolyzable ions are removed by passing the sample through an ion-exchange column with selection of both the resin and transport solution being dependent on the hydrolyzable ions present and the strength of the complexes formed with NO_3^- or Cl^-. After removal of the hydrolyzable ions, the free acid is determined colorimetrically using thymol blue in a buffered solution. Experimental conditions for preforming the determination in the presence of the above-mentioned ions are tabulated. Using the tabulated conditions, no significant bias was observed in the analysis so long as the breakthrough capacity of the resin column was not exceeded. In the analysis of a 0.2M hydrolyzable acid solution containing 0.2M La^{3+}, the relative standard deviation was 1.1%. (B.L.M.)

14449 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF SMALL SAMPLES OF WITWATERSRAND ORE FOR GOLD. **de Lange, P. W.; de Wet, W. J.; Turkstra, J.; Venter, J. H. (Atomic Energy Board, Pretoria). Anal. Chem., 40: 451-4(Feb. 1968).**

Thermal neutron activation followed by graphical analysis of the γ spectrum resulting from the 412-keV emission of ^{198}Au and the 277 keV emission of ^{237}Np was applied to the analysis of small samples of Witwatersrand ore. One- to 2-g ore-bearing samples were prepared according to the methanol wet-mixing method previously applied to U ore samples. (B.L.M.)

14450 PARTICLE SIZE DISTRIBUTION OF PARTICLES FROM 10 TO 2000 MICRONS BY SEDIMENTATION ANALYSIS. **Bate, L. C.; Dyer, F. F. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Anal. Chem., 40: 468-70(Feb. 1968). (ORNL-P-3207).**

A sedimentation method is described for application to the determination of concentration of nonfragile clinkers (particles > 10 μ in diameter) in ThO_2 fired to high temperatures and to measurement of particle-size distributions of fragile particles that are radioactive and too large to be studied by conventional sedimentation methods. The particles are released at the top of a column to begin sedimentation through a dispersing medium. The viscosity and density of the dispersing medium are adjusted so that the particles settle according to Stokes' law. For the clinkers analysis a 45.86 centipoise glycerol–water solution was found to be most satisfactory, but other media from pure glycerol to water can be used depending on the particle size range and density of the particles. The radioactivity of the particles can be measured without separating them from the supporting medium. The particle size resolution of the method can be increased to any desired degree by increasing the number of fractions taken and/or by using longer columns. (B.L.M.)

14451 USE OF NEUTRON-ACTIVATION ANALYSIS IN THE STUDY OF EXOGENOUS INCLUSIONS IN FERROUS MATERIALS. **Malvano, R.; Rossi, F. (Societa Ricerche Impianti Nucleari, Saluggia, Italy). Atti Notiz., Ass. Ital. Met., 21: No. 2, 35-9 (1966). (In Italian).**

Small amounts of La or Sm, as oxide, may be incorporated in the refractory materials used for moulds or furnace linings and so be present as refractory inclusions in castings or ingots of cast iron or stainless steel. Such inclusions can be detected by determination of ^{140}La and ^{153}Sm by γ spectrometry after irradiation of a sample of the metal. Increased sensitivity was attained by shielding the sample with cadmium foil during irradiation or by dissolving the irradiated sample in acid and measuring the activity of the solution, either directly or after chemical separation by extraction of Fe into isopropyl ether, followed by ion exchange to remove Mo, W, As, Cu, and Co. (Anal. Abstr.)

14452 MICRO-DETERMINATION OF MOLYBDENUM(VI) WITH PHENYLAZOXINE S DYE. **Goyal, S. S.; Tandon, J. P. (Univ. of Rajasthan, Jaipur, India). Z. Naturforsch., 23B: 142-4(Feb. 1968).**

Micro-determination of molybdenum(VI) with 7-phenylazo-8-hydroxyquinoline-5-sulfonic acid is described. Molybdenum(VI) forms a yellow, water soluble complex in the pH range from 2.5 to 5.5. 1:1 (M:L) stoichiometry was established by Job's and molar ratio methods. The color reaction is instantaneous and the color intensity remains unchanged for about 24 hours. Beer's law is obeyed from 0.2 to 8.0 ppM of molybdenum per ml. The molecular extinction coefficient of the complex was found to be $E_{420\ m\mu} = 1.38 \times 10^4$, giving Sendell's sensitivity coefficient 0.0069 μg of molybdenum per cm^2. The values of formation constant (log K) and free energy of formation (ΔF^0) obtained by three methods are 5.40 ± 0.3, 5.20 ± 0.15, 5.62 ± 0.03 and

(−7.50 ± 0.40, −7.22 ± 0.20, −7.80 ± 0.04 Kcals) respectively. The interference due to a number of anions and cations in the determination of molybdenum(VI) was also studied. (auth)

14453 PROGRESS REPORT ON USE OF PORTABLE RADIOISOTOPE X-RAY FLUORESCENCE ANALYSER. Darnley, A. G.; Gallagher, M. J. (Geological Survey of Great Britain, London). Inst. Mining Met. Trans./Sect. B, 75: 105-6(1966).

The use of the apparatus described by Bowie et al. (Analyt. Abstr., 1966, 13, 5322) was extended to in situ underground readings for Sn. In every instance where the distribution of Sn was very heterogeneous, 80% of the measurements were within ±50% of the results of chemical assay. An annular 15-curie ^{3}H–zirconium source was developed for measurements on copper ores with use of nickel and cobalt filters; a limit of detection of 0.25% of Cu is indicated. The same source can also be used for the determination of Zn by using copper and nickel filters; the detection limit is again 0.25%. Down to 0.1% of Pb can be determined with a ^{57}Co source with iridium and rhenium filters, and tests are being made with a ^{109}Cd source with zirconium and yttrium filters for determining Mo. Results are obtained on readings taken during <1 min per sample. (Anal. Abstr.)

14454 SUBSTOICHIOMETRIC DETERMINATION OF PLATINUM BY ACTIVATION ANALYSIS. Krivanek, M.; Kukula, F. Isotopenpraxis, 3: 441-3(1967). (In Russian).

A technique for the selective separation of platinum was developed based on the ability of bivalent platinum to form firm complexes with diethyldithiocarbamate in a large interval of acidity. Copper diethyldithiocarbamate, which is comparatively stable in acid solutions, was used for extractions. Determination of platinum is only perturbed in presence of Hg, Au, and Pd. Since tetravalent platinum is not extracted in form of diethyldithiocarbamate the interfering elements can be eliminated by preliminary extraction by the same reagent or its diethylammonium salt, and after reduction to its bivalent form platinum can be extracted selectively. The technique was applied to the determination of platinum in aluminium, gallium, a sol of biological material, and tea by activation analysis. (auth)

14455 MEASUREMENTS OF THE ISOTOPIC RATIOS OF NICKEL IN IRON METEORITES USING NICKEL CARBONYL. Suzuki, Masaru; Matsuo, Sadao (Tokyo Univ.). Geochem. J. (Nagoya), 1: 55-60(June 1967).

The isotopic ratios of nickel in a shelf reagent, a dunite, and three meteoritic irons were measured. $Ni(CO)_4$ was synthesized from samples and introduced into a mass spectrometer in gaseous form. All the precisions of the isotopic ratio measurements were within 1%. The relative abundance of ^{64}Ni was lower than that given by White and Cameron by 20%. There was no significant difference in the isotopic ratios of $^{60}Ni/^{58}Ni$, $^{61}Ni/^{58}Ni$, $^{62}Ni/^{58}Ni$, and $^{64}Ni/^{58}Ni$ between samples analyzed. The method needs further improvements to remove troubles caused by the decomposition of $Ni(CO)_4$ in the ion source of the mass spectrometer. (NSA of Japan)

14456 RADIOCHEMICAL SEPARATION OF Ag, Au, Cd, Co, Fe, In, AND Zn PRESENT AS TRACE IMPURITIES IN GALLIUM. Bujdoso, E.; Miskei, M. Kohasz. Lapok, 99: 281-3(1966). (In Hungarian).

Isotope tracer studies were employed for separation of impurities from gallium by means of extraction with isopropyl ether and the use of Varion AP anion-exchange resin. The aqueous phase contained Ag, Cd, Co, (Ga), In, and Zn; Au, Fe, and Ga were present in the organic phase. Elution of the ions of the aqueous phase from the ion-exchange column was effected with hydrochloric acid solutions of different concentrations. The separation procedure is suitable for determination of trace impurities in activated gallium with high sensitivity. The activity of tracers in the measuring system used was 80 to 110 × 10^3 cpm/3 ml. The procedure is relatively quick and simple. It may be advantageously used as a routine method. (Hung. Tech. Abstr.)

14457 POTENTIOSTATIC COULOMETRY AND ITS APPLICATION TO THE DETERMINATION OF URANIUM AND PLUTONIUM. Schmid, E. Oesterr. Chem.-Ztg., 67: 8-16(1966). (In German).

After an introduction to the theory and instrumentation of potentiostatic coulometry, the most important factors in the construction of the cell are described in detail. Determination of U and Pu by this technique is reviewed. (Anal. Abstr.)

14458 ANALYSIS OF SULPHURIC ACID SOLUTIONS BY β-RAY BACK-SCATTERING. Marcu, G.; Tolea, F. (Univ. Babes-Bolyai, Cluj). Stud. Univ. Babes-Bolyai, Ser. Chem., 11: 7-14(1966). (In Rumanian).

Solutions containing up to 100% H_2SO_4 were analyzed by means of apparatus described previously with use of a 10-mCi ^{204}Tl source. Equations and graphs were derived for calculating H_2SO_4 concentrations from 9 to 100% with an error of ±0.5%. A determination took only 2 to 3 minutes and the results agreed well with those obtained by the volumetric method. The method can readily be adapted for continuous automatic control of the production process. (Anal. Abstr.)

14459 SERIAL STUDY OF THE CONTAMINANTS OF SILICON USED FOR THE PREPARATION OF SEMICONDUCTORS, BY MEANS OF NONDESTRUCTIVE NEUTRON-ACTIVATION ANALYSIS. Bogancs, Janos; Quittner, Pal; Szabo, Elek (Central Physics Research Inst., Budapest). Magy. Kem. Foly., 73: 346-9(Aug. 1967). (In Hungarian).

A nondestructive neutron-activation analytical method was worked out for determination of the contaminants of silicon used for the manufacture of semiconductors. The gamma spectrum of the samples irradiated in 10^{13} thermal neutron flux for 24 to 48 hours was measured, after cooling for 24 to 72 hours, by means of a scintillation detector and multichannel analyzer. The samples investigated exhibited contamination with Cu, As, Sb, Na, Au, W, and P. (JPRS)

14460 APPLICATION OF ATOMIC ABSORPTION TO THE DETERMINATION OF Al, Fe, AND Ni IN THE SAME URANIUM-BASE SAMPLE. Jursik, M. L. (National Lead Co. of Ohio, Cincinnati). Contract AT(30-1)-1156. At. Absorption Newslett., 6: No. 2, 21-3(Mar.-Apr. 1967).

Atomic absorption spectrophotometry was applied to the determination of Al, Fe, and Ni in a single sample of uranium metal. The technique was rapid and as accurate and precise as the colorimetric procedures for these elements. The analyses were performed by first dissolving the uranium sample in nitric acid, and then extracting into a tributyl phosphate–carbon tetrachloride solution. The aqueous phase that contained the Al, Fe, and Ni was aspirated into the flame. Aluminum in the range from 600 to 1000 ppM, uranium basis, was determined with a high-temperature burner and a nitrous oxide–acetylene flame. Iron in the range from 100 to 400 ppM and Ni in the range from 50 to 200 ppM were determined with the conventional slot burner and an air-acetylene flame. (auth)

14461 DETERMINATION OF THE CALCIUM CONTENT OF NaCl BY ACTIVATION ANALYSIS. Sacha, Juraj. Fyz. Cas., 17: No. 2, 73-81(1967).

A method of determining the Ca content in NaCl is described. After chemical treatment that helps to decrease the interfering ^{35}S and ^{32}P contents by a factor of 10^4 to 10^5, the activity of ^{45}Ca deposited on two supporting sheets of different thickness was measured. This permits finding the ratio of ^{35}S and ^{32}P to ^{45}Ca activity. (JPRS)

14462 RADIOISOTOPE DILUTION TECHNIQUES FOR MEASUREMENT OF BODY COMPOSITION IN HEALTH AND DISEASE. Morgan, Alfred P.; Boyden, Caryl M.; Moore, Francis D. (Peter Bent Brigham Hospital, Boston). Radiol. Clin. N. Amer., 5: 193-204(Aug. 1967).

Use of D_2O, T_2O, ^{131}I-iodoantipyrine, and other radioisotopes to measure body water, ^{42}K to measure exchangeable potassium, ^{24}Na for exchangeable sodium, and ^{82}Br for extracellular water is reviewed. In the measurement of total body water, T_2 and D_2 exchange with hydroxyl and sulfhydryl groups, and the antipyrine radioiodine is metabolized and protein bound. Total-body K is measured by injection of ^{42}K; for the hypothetical 25-year-old male in the example cited, this isotope exchanges with 3716 meq of K, all but about 70 meq being intracellular, the small extracellular component being the product of extracellular fluid volume and extracellular K concentration. For the equilibrium value, it is convenient to obtain the $^{42}K/^{39}K$ specific activity in urine due to the low concentration of K in the plasma. For measurement of ionically active sodium, 40 hr are allowed for equilibration of injected ^{24}Na with the exchangeable Na mass, in which about 75% of total body sodium is represented. For the bromide volume in estimation of extracellular water, ^{82}Br is injected with the K and Na isotopes. An equilibrium blood sample is obtained 45 hr later. Bromide-82 and chloride are considered to have an equivalent metabolism. A figure for exchangeable Cl is also derived from $^{82}Br/Cl$ specific activity. Details of clinical methods using ^{3}H, ^{42}K, ^{24}Na, and ^{82}Br are outlined, showing the counting techniques used. (BBB)

14463 THE DETERMINATION OF NON-METALLIC ELEMENTS IN URANIUM, ITS COMPOUNDS, AND ALLOYS. Klusal, Ivan (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez. Inst. of Nuclear Research, Czechoslovak Academy

of Sciences, Prague). Chem. Listy, 61: 1436-54(Nov. 1967). (In Czech).

A brief review is given on analytical methods for the determination of nonmetallic elements in uranium, its compounds, and alloys. Properties of uranium carbides, nitrides, and silicides were investigated. Nuclear reactor materials, fuel element fabrication, determination of gases in metals, and microchemical techniques are discussed. (288 references). (R.V.J.)

14464 THE CONCENTRATION OF Cl, Na, Br, Cu, Sr, AND Mn IN HUMAN MIXED SALIVA. Arwill, T.; Myrberg, N.; Soeremark, R. (Univ. of Umea, Sweden). Odontol. Revy, 18: 1-6(1967).

Neutron activation analysis was used to determine the content of these six elements in human saliva. Dried saliva samples and standards were irradiated with thermal neutrons at a flux of 1.4×10^{12} neutrons cm^{-2} sec^{-1} for 30 min. After irradiation, the sample was dissolved in concentrated H_2SO_4, heated, and processed as described earlier. After the radioactive elements were adsorbed into various ion exchange resins, they were counted in a 3" × 3" NaI (Tl) scintillation well crystal, and the activity was recorded with a 256-channel analyzer. The range of values of the elements obtained in saliva obtained by the subjects' chewing paraffin and in unstimulated saliva, respectively, in parts for million of fresh weight were: Cl 126 to 529, 45 to 286; Na 54 to 310, 4.1 to 47; Br 1.1 to 2.6, 1.5 to 3.6; Cu 0.015 to 0.052, 0.013 to 0.053; Sr 0.01 to 0.063, 0.0077 to 0.016; and Mn 0.049 to 0.0086, 0.0014 to 0.0037. Trace amounts of Mo and Rb were also observed. The values for Na and Mn in paraffin-stimulated saliva are significantly higher than in the unstimulated saliva, but no similar differences were observed for the other elements. The contents of these elements are lower in saliva than in tooth enamel. There is also a marked difference in the contents of the elements in saliva and in serum. (BBB)

14465 MASS SPECTROMETRIC DETERMINATION OF CALCIUM ISOTOPE VARIATIONS. Miller, Yu. M.; Ustinov, V. I.; Artemov, Yu. M.; Kazakov, G. A. Geochem. Int. (Engl. Transl.), 3: 929-33(1966).

Methods for determination of Ca isotope variations are described and geochemical implications of the recorded variations are discussed. Calcium isotope composition was measured with a standard MI-1311 mass spectrometer employing a triple filament source. The recorded ratio $^{40}Ca/^{44}Ca$ was selected because of the greater percentage abundance of these Ca isotopes. Some aspects of the use of chlorides to obtain isotopic ratios of metals are considered. The use of chlorides as the working substance is based on the increase in efficiency of W filament in the presence of Cl_2. Addition of $ZnCl_2$ to the sample to be analyzed promoted constant formation of Cl vapors in the region of the ionizer. Replacement of W by Ta, Mo, Pt, and Re did not yield any perceptible advantage with the recording method employed. Calcareous rocks of the Tithonian stage of the Upper Jurassic, which contains rocks with various concentrations of secondary dolomites, showed a maximum difference in isotope composition of 5.5‰. The dolomite Ca was "heavier" than the other Ca. (BBB)

14466 OXYGEN ISOTOPIC COMPOSITION OF SULFATES. PART 2. PRELIMINARY RESULTS ON OXYGEN ISOTOPIC VARIATION IN SULFATES AND THE RELATIONSHIP TO THEIR ENVIRONMENT AND TO THEIR $\delta^{34}S$ VALUES. Rafter, T. A.; Mizutani, Y. (Dept. of Scientific and Industrial Research, Lower Hutt, N. Z.) N. Z. J. Sci., 10: 816-40(Sept. 1967).

A wide variety of sulfates were examined to determine the spread of $\delta^{18}O$ values in sulfates, and whenever possible the $\delta^{18}O$ values were correlated with those of the water from which they were recovered. Any relation between $\delta^{34}S$ and $\delta^{18}O$ values in sulfates and the possible relation between $\delta^{18}O$ values in co-existing sulfates and carbonates were looked for. Chemical procedures for the recovery of sulfate as $BaSO_4$ in the study of oxygen isotopes in sulfates were established. The reproducibility of method was improved to ±0.18‰. The oxygen isotope ratio of sulfates was studied in sulfate from Antarctic lake water, geothermal waters, seawaters, rainwaters, and a number of barites. The $\delta^{18}O$ value in sulfate varied from −9 to +25‰ with respect to standard mean ocean water (SMOW). A positive correlation between the $\delta^{18}O$ value in sulfates and in the waters in which they exist was apparent in specimens so far examined. A positive correlation between $\delta^{34}S$ and $\delta^{18}O$ in 50 sulfates examined also was observed. This correlation could be due to bacterial as well as physical-chemical processes. Isotopic equilibrium temperatures could not be calculated from data so far available. (BBB)

14467 SPECTROPHOTOMETRIC DETERMINATION OF CERIUM WITH SULFANILIC ACID AND SPECTROPHOTOMETRIC DETERMINATION OF VANADIUM IN STEEL AND CRUDE OIL WITH SULFURIC ACID. Dieter, Lowell Henry. Grand Forks, N. D., Univ. of North Dakota, 1966. 123p. Thesis.

Cerium(IV) reacted with sulfanilic acid producing a red color which could be used for the spectrophotometric determination of cerium. The intensity of the color produced from the reaction depended upon the concentration of cerium, the time interval between mixing the reactants and measuring the % transmittance of the solution, the pH of the solution, and the temperature of the reaction mixture. These variables were investigated and optimum conditions were determined for the analytical procedure. Maximum absorption occurred when three or more moles of sulfanilic acid were added to one mole of cerium(IV). The bright red color faded rapidly to a dull red-brown color. The absorbance decreased linearly up to five minutes after mixing. At this time, the rate of fading decreased abruptly, but still remained linear. A pH of 1.70 was chosen as standard for all determinations. The % transmittances of the solutions increased linearly with temperature. Temperature errors were eliminated by preparing standard samples at the same time as the unknowns. The % transmittances of all the solutions were measured three minutes after mixing. Using these conditions 28 to 210 ppM of cerium could be determined at 495 mμ. A total of fifty-three determinations were made with an average difference from the known values of less than 3%. Strong oxidants, colored ions, and neodymium(III) in concentrations greater than fifty times the concentration of cerium interfered with this method. Cerium was separated from interfering materials by means of an oxalate precipitation prior to color development. Vanadium(V) forms an intense yellow color with any non-reducing acid; but the color fades rapidly in the presence of a large amount of water. However, when 25.00 ml of a vanadium(V) unknown were mixed with 75.0 ml of concentrated sulfuric acid, the color was stable enough to determine 40 to 280 ppM of V at 450 mμ. Although this reaction is specific for vanadium(V), the presence of colored materials interfered with the determination. Fe, Ni, Cr, Cu, and Mn in steel samples formed colored solutions under the conditions of the analysis. These materials were removed from the sample by $NaHCO_3$ precipitation followed by mercury-cathode electrolysis. Steel samples were dissolved in dilute H_2SO_4. Any interfering materials were removed by $NaHCO_3$ precipitation and mercury-cathode electrolysis. Vanadium was oxidized to the pentavalent state with $KMnO_4$ and the yellow color was developed with concentrated H_2SO_4. A total of thirty-three determinations were made on seven steel samples with an average difference of 2% from the known values. Concentration of V and other inorganic constituents of petroleum was accomplished by ashing. Samples were mixed with H_2SO_4 before ashing to prevent the loss of V. The inorganic ash was dissolved in H_2SO_4 and the resulting solution was electrolyzed over a mercury cathode to remove interfering materials. Although good results were obtained, the method is not recommended because it requires large samples and the time required to process these samples makes the method impractical. (Disser. Abstr.)

14468 SVENSK NATURVETENSKAP 1967. (Swedish Natural Science 1967). Afzelius, B. (ed.). [Stockholm], Statens Tekniska Forskningsrad, 1967. 374p. 36.00 Sw. Crs.

Progress is reported on natural scientific research in Sweden. Among the topics are: plasma physics and electric discharges in gases, free radicals in polymer chemistry, electron microscopy for studies of macromolecules, activation analysis, research activities at the Swedish Research Councils' Laboratory, and fallout in Sweden. (Sweden)

14469 AKTIVATSIONNYI ANALIZ. (Activation Analysis). Kuznetsov, R. A. Moscow, Atomizdat, 1967. 333p.

The basic principles and method of activation analysis are described. A brief history of the development of activation analysis and its uses is presented. The equations for activation and the absolute and relative methods of neutron activation analysis are examined. The nuclear particle sources are covered and particle bombardment and particle interactions with the substance are considered. Neutron activation and photoactivation analysis and analysis using charged particles are discussed. Thermal neutron activation analysis, sensitivity of the method and instrumentation, basic chemical methods for separating activated elements, and the efficiency of precipitation, ion-exchange chromatography, and extraction methods in activation analysis are considered. Various identification methods and quantitative determination of activated elements are discussed, including the uses of scintillation γ spectrometers, delayed neutrons, and semiconductor detectors. (412 references) (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 14513, 14552, 14561, 14566, 14723, 15139, 15141, 15182, 15197, 15375, and 15380.

14470 (AERE-M-1829) pH CONTROL OF ALKALINE WATERS BY ION-EXCHANGE USING A SINGLE MIXED BED. Monahan, J.; Hill, S. S. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 19p. Dep. CFSTI. UK.

It was demonstrated in the laboratory that a mixture of a strongly acidic cation resin in the ammonium, potassium, or lithium forms and a strongly basic anion resin in the hydroxyl form will maintain the pH of circuit water at any value in the range from 8.5 to 10.0 for limited periods. The use of a single mixed bed ion exchanger to maintain the pH value of an experimental loop water at approximately 9.0 and 9.5 is described. (auth) (UK)

14471 (AWRE-O-54/65) URANIUM COMPATABILITY STUDIES. PART 7. A NOVEL METHOD FOR INVESTIGATING THE URANIUM–WATER REACTION. Orman, S.; Robertson, P. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1965. 16p. Dep. CFSTI. UK.

A novel method for investigating the binary uranium–water and ternary uranium–water–retarder systems has been devised. Preliminary experiments conducted with the apparatus are described and the results discussed. The method is based on the observation that in a closed system uranium will react with water vapor without appreciable pressure change if unsaturated conditions prevail. Incorporation of a heated palladium diffuser into the system allows removal of the product hydrogen without affecting the course of the reaction. The use of the palladium diffuser will enable accurate investigations of the rate-vapor pressure relationship to be made at low vapor pressures, and should be equally useful in establishing a threshold value for the efficiency of a retarding agent. (UK)

14472 (AWRE-R-1/62) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 5. THERMAL CONDUCTIVITY OF THE FUSED EUTECTIC MIXTURE OF SODIUM FLUORIDE AND URANIUM TETRAFLUORIDE. Webb, D. P. D.; Cameron, W. (Atomic Weapons Research Establishment, Aldermaston (England)). Sept. 1962. 23p. Dep. CFSTI. UK.

The thermal conductivity of the fused eutectic $NaF-UF_4$ (74 mole % NaF, 26 mole % UF_4) was measured by a modified Lees' disc method over the temperature range 650 to 750°C. The conductivity increased from 5.9×10^{-4} cal/cm/s/°C at 650°C to 12.7×10^{-4} cal/cm/s/°C at 750°C in an approximately linear manner. The difference between these results and recent predicted values is briefly discussed. (auth) (UK)

14473 (AWRE-R-2/61) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 4. VAPOUR PRESSURE OF THE FUSED EUTECTIC MIXTURE OF SODIUM FLUORIDE AND URANIUM TETRAFLUORIDE. Hutchinson, S. K.; Baker, M. McD.; Jones, P. M. S.; Ridgway, Sheila P. (Atomic Weapons Research Establishment, Aldermaston (England)). [1961]. 26p. Dep. CFSTI. UK.

The rates of weight loss from the fused $NaF-UF_4$ eutectic (74 mole percent NaF) were measured over the temperature range 700 to 1100°C. The results fit the equation $\text{Log}_{10}\,\mu = -6.06 + 1.21 \times 10^{-2}$ (T°C – 700), where μ is the weight loss in g/cm²/sec at T°C. The results are interpreted as showing the independent existence of NaF, UF_4, and $NaUF_5$ in the vapour phase, and their partial vapour pressure equations were evaluated. (auth) (UK)

14474 (AWRE-R-7/58) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 2. SURFACE TENSION OF THE FUSED EUTECTIC MIXTURE OF SODIUM FLUORIDE AND URANIUM TETRAFLUORIDE. Hutchinson, S. K.; Baker, M. McD.; Jones, P. M. S.; Bleloch, J. W. (Atomic Weapons Research Establishment, Aldermaston (England)). [1959]. 18p. Dep. CFSTI. UK.

The surface tension of the fused eutectic $NaF-UF_4$ (74 mole % NaF and 26 mole % UF_4) was determined by two methods: shape measurements of a sessile drop, and measurement of the force required to detach a ring from the liquid surface. The results obtained by the two methods are in good agreement and conform over the temperature range 613 to 750°C to the equation: $\gamma_t = 220 - 0.22(t - 613)$ where γ_t is in dynes/cm and t is in °C. In the range 750 to 850°C the surface tension is no longer linear with temperature; the reasons for this are discussed. (auth) (UK)

14475 (AWRE-R-8/58) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 3. VISCOSITY OF THE FUSED EUTECTIC MIXTURE OF SODIUM FLUORIDE AND URANIUM TETRAFLUORIDE. Hutchinson, S. K.; Baker, M. McD.; Bleloch, J. W. (Atomic Weapons Research Establishment, Aldermaston (England)). [1959]. 24p. Dep. CFSTI. UK.

The viscosity of the fused eutectic $NaF-UF_4$ (74 mole % NaF and 26 mole % UF_4) was measured by determining the damping of the torsional oscillation of a nickel sphere containing the melt. The viscosity was found to fall from 9.8 ± 0.3 cp at 608°C (eutectic point) to 2.4 ± 0.3 cp at 936°C. An equation is given relating viscosity to temperature. The discrepancy between the results obtained and semi-empirical predictions is discussed. (auth) (UK)

14476 (BMwF-FBK-67-87) JAHRESBERICHT 1966 UEBER FORTSCHRITTE IN DER VERGLEICHENDEN CHEMIE DER LANTHANIDEN- UND AKTINIDENELEMENTE. (Comparative Chemistry of Lanthanide and Actinide Elements. Annual Progress Report, 1966). (Munich Univ. (West Germany). Institut fuer Anorganische Chemie). Oct. 1967. 12p. (In German). Dep.

Progress in comparative chemistry of lanthanide and actinide elements is reported. The vapor phase hydrolysis measurements of the lanthanide(III) chlorides $ErCl_3$, $TmCl_3$, YCl_3, and $PmCl_3$ were evaluated, the thermodynamic data thus obtained are reported. The x-ray data obtained for $Nd_2(C_2O_4)_3 \cdot 10H_2O$ and $Sm_2(C_2O_4)_3 \cdot 10H_2O$ in 1965 were revised using Weissenberg, Buerger, and rotating crystal photographs. The space group was unambiguously found to be $P2_1/c$, the lattice constants of completely reduced unit cells could be determined for $Nd_2(C_2O_4)_3 \cdot 10H_2O$, $Pm_2(C_2O_4)_3 \cdot 10H_2O$, and $Sm_2(C_2O_4)_3 \cdot 10H_2O$. A special working enclosure for Ra-226 work is briefly described. The reactions observed in treatment of UCl_4 with borane are reported. The unit cell of $Am_2(C_2O_4)_3 \cdot 10H_2O$ was determined, Am(III) formate, $Am(HCOO)_3$, and Am(III) carbonate dihydrate, $Am_2(CO_3)_3 \cdot 2H_2O$, were synthesized and were identified by their x-ray powder patterns. The thermal decomposition of $Am_2(CO_3)_3 \cdot 2H_2O$ was studied in a mass spectrometer. A molybdenum cup apparatus for vapor pressure determinations was built and calibrated using $SnCl_2$ as standard. (auth)

14477 (BNWL-530) THE WASHOUT OF METHYL IODIDE BY HYDRAZINE SPRAYS. PART A. CHEMICAL STUDIES OF THE METHYL IODIDE–HYDRAZINE SYSTEM. PART B. SPRAY DEMONSTRATION EXPERIMENTS. Progress Report Completed through September 1967. Burger, L. L.; Hasty, R. A.; Schwendiman, L. C.; Mishima, J.; Postma, A. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1, 1967. Contract AT(45-1)-1830. 94p. Dep. CFSTI.

The potential value of hydrazine as a reactive additive to sprays for removing methyl iodide from reactor containment atmospheres was investigated along two lines. The first was a study of the basic physical chemistry and kinetics of the reaction; the second was a study of spray removal efficiency. The gas-phase reaction was relatively slow; only 10% of the methyl iodide vapor reacted in over one hour in a large excess of hydrazine vapor. The removal rate of methyl iodide from a gas phase to a stagnant pool of hydrazine in a small-scale apparatus was established as a function of surface area of the pool, vapor space, and hydrazine concentration in solution. The homogeneous liquid-phase reaction is of great interest for spray models and the measured reaction rate constant was found to be the order of 3×10^{-2} liter mol^{-1} sec^{-1}. The partition coefficient between vapor and water was measured as a function of temperature and an equation written for this relation. Spray demonstrations using an alkaline 5 wt % hydrazine showed: approximately 99% of airborne methyl iodide could be removed in 4 hours using a fine spray (140 μ diameter) with a density of 0.1 gpm/ft², increasing the drop size of the spray reduces its efficiency, and increasing the temperature increases rate of spray removal. Some criteria helpful in evaluating compounds for use as a spray additive are discussed. A washout model mathematically describing the influence of various parameters on the removal of methyl iodide from the gas phase by a spray is being developed. (auth)

14478 (CU-2660-39) HIGH TEMPERATURE THERMAL PROPERTIES OF GASES AND VAPORS. Progress Report, April 1967–March 1968. Bonilla, Charles F. (Columbia Univ., New York. Liquid Metals Research Lab.). Dec. 1967. Contract AT(30-1)-2660. 20p. Dep. CFSTI.

Measurements were made on the viscosity of vapors of Cs, Rb, K, and Na, and the vapor pressure, density-temperature relation, and thermal conductivity of Cs. Velocity fluctuations in the boundary layer of falling liquid films during turbulent fluid flow were also measured. Data are tabulated. (D.L.C.)

14479 (NIJS-R-509) NMR INVESTIGATION OF HYDRATED URANIUM DIOXIDE. Blinc, R.; Brcic, B. S.; Komac, M.; Kolar, D.; Pintar, M.; Zupan, J. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Sept. 1967. 9p. (CONF-671008-5). Dep.

From Symposium on Sol-Gel Processes for the Production of Ceramic Nuclear Fuels, Turin, Italy.

It was demonstrated that the composition of $UO_2 \cdot xH_2O$ depends upon the preparation conditions. The characteristic Weiss con-

stants were calculated. NMR measurements do not justify the formula $U(OH)_4$. (auth)

14480 (NYO-1725-28) MECHANISMS OF ACID-BASE CATALYSIS AND STUDIES IN DEUTERIUM OXIDE AS SOLVENT. Technical Progress Report, January 1, 1966–December 31, 1967. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). Dec. 28, 1967. Contract AT(30-1)-1725. 5p. Dep. CFSTI.

In an effort to explain puzzling rate data in the decarboxylation of azulene-1-carboxylic acid, the protonation of the molecule and the decarboxylation at various acidities were studied. NMR spectra confirmed protonation occurred on the carbon at the 3-position of the azulene ring. In dilute solution of a strong acid such as perchloric, at concentration of from 0.001 to 0.03M, the reaction was acid catalyzed; however, at a slightly higher acidity, 0.06 to 0.3M perchloric acid, the reaction was independent of acid concentration. The mechanism that was consistent with all the data was: $RCO_2H + H_3O^+ \rightleftharpoons RH^+CO_2H + HO \rightleftharpoons RH^+CO_2^- + H_3O^+ \rightleftharpoons RH + CO_2$. Deuterium solvent isotope effects support the proposed mechanism. A study of base-catalyzed removal of proton from a carbon base acid, cyanocarbon acids that are essentially hydrocarbons in which certain CH entities are made relatively acid by the presence of nearby cyano groups, was made. Extensive study was made with 1,4-dicyano-2-butene. The base catalyzed reaction of β-ketones is being studied for further evidence on "medium effects." (D.H.M.)

14481 (ORNL-4139, pp 43-7) THORIUM FUEL-CYCLE STUDIES. (Oak Ridge National Lab., Tenn.).

Analyses were made to determine the purity of crystalline thorium nitrate obtained from one supplier and the properties of sols and spheres prepared from this material were evaluated. In view of the favorable results found, a 50-ton quantity was requested for future use. Many operating difficulties encountered during the preparation of microspheres would be minimized if the sol droplets were uniform in size; therefore, the development of dispersion devices has continued. Sol droplets formed by use of capillaries that are mechanically connected to, and vibrated by, an electronic vibrator are more uniform at optimum conditions than those from any other type of disperser. An inclined settler was effective for the collection of gel microspheres that are 10 μ in mean diameter. (auth)

14482 (ORNL-4196, pp 90) INORGANIC PREPARATIONS. LaValle, D. E.; Quincy, R. B. (Oak Ridge National Lab., Tenn.).

The preparation of fused salts, mostly rare-earth-metal halides, the preparation of compounds of the spinel ($MgAl_2O_4$) structure, the preparation of GeO_2 glasses, the production of high-purity KCl, and the heat treatment of rare earth alloys are reported. A project was undertaken to produce 50 g of the isotope ^{160}Gd in the metallic form by reduction of $^{160}GdF_3$. A series of alloys and compounds that contain isotopes of germanium and of nickel were prepared. (auth)

14483 (ORNL-4196, pp 91-2) ORGANIC PREPARATIONS. Thomason, P. F.; Holsopple, H. L. (Oak Ridge National Lab., Tenn.).

The preparation of p-aminobenzylamine, heptadecylamine, tri-n-butylbenzylphosphonium chloride, tetra-n-butylphosphonium bromide, α,α'-dipiperidyl, cesium p-ethylbenzenesulfonate, and bicyclo-[1.1.0]butane is reported. (auth)

14484 (ORNL-TM-2056) PREPARATION AND PRELIMINARY STUDIES OF CHLORIDE-STABILIZED UO_2 SOLS. Helton, D. M.; Bell, J. T.; Krohn, N. A. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 17p. Dep. CFSTI.

A method of preparing chloride-stabilized aqueous uranium(IV) oxide sols is described. Sols approximately 0.5 to 0.7M in total uranium were concentrated to greater than 8.0M. Electron photomicrographs and selected area diffraction patterns were obtained on the sols at various stages of the preparation. Viscosity studies on concentrated sol showed that initially high values could be drastically reduced by addition of small amounts of U(VI) as UO_3. Spectrophotometric studies in the visible and ultraviolet regions showed a combination of multiple scattering and absorption, which yielded an uninterpretable spectrum. (auth)

14485 (UCRL-17916) THE MOLECULAR-BEAM ELECTRIC RESONANCE SPECTRA OF NaCl AND NaBr. Melendres, C. A.; Hebert, A. J.; Street, K. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 45p. Dep. CFSTI.

The radiofrequency Stark spectra of $^{23}Na^{35}Cl$, $^{23}Na^{37}Cl$, $^{23}Na^{79}Br$, and $^{23}Na^{81}Br$ were observed by the molecular-beam electric resonance method of molecular spectroscopy. Analysis of spectral lines obtained by observing transitions of the type $J = 1$, $M_J = \pm 1 \rightarrow J = 1$ $M_J = 0$ at strong electric fields yielded molecular dipole moments and nuclear hyperfine interaction constants for the different vibrational states of the molecules. (auth)

14486 (ANL-Trans-574) PREPARATION OF NEPTUNIUM AND PLUTONIUM IN THE 7-VALENT STATE. Krot, N. N.; Gel'man, A. D. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Dokl. Akad. Nauk SSSR, 177: 124-6(1967). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The existence of a possibly unstable heptavalent state of neptunium appears to be quite probable in view of the fact that there is only one 5*f* electron in the neptunium ion. Experiments were carried out to obtain Np(VII) by the action of ozone on hexavalent neptunium in alkaline media. Passage of ozone through a suspension of sodium or potassium neptunate in 0.5 to 3.5M alkalies results in the dissolution of the solid and the formation of a brilliant green solution. The absorption spectrum of these solutions exhibits bands with maxima at 412 and 625μ; the coloration follows the Lambert–Beer's law; it is practically independent of the alkali concentration or the duration of the ozone treatment. Addition of acids results in the immediate disappearance of the green color. It was concluded that the Np(VI) is oxidized in alkaline media to the heptavalent state and dissolves, forming the colored anion. Similar results were obtained with plutonium. The heptavalent plutonium solutions are unstable, probably because Pu(VII) is formed by the spallation of one of the two 5*f* electrons of Pu(VI). (TTT)

14487 (UCRL-Trans-10222) PREPARATION AND SOME PROPERTIES OF RARE EARTH PHOSPHIDES. Samsonov, G. V.; Vereykina, L. L.; Endrzheevskaya, S. N.; Tikhonova, N. N. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from Ukr. Khim. Zh., 32: 115-18(1966). 10p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 45686. (P.C.H.)

14488 DIFFUSION OF RARE GASES IN CALCIUM FLUORIDE. RARE GASES IN SOLIDS. 35. Biersack, J.; Brenner, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nukleonik, 10: 264-7(1967). (In German).

In single crystals of CaF_2 and of U-doped CaF_2 the diffusion of Ar, Kr, and Xe was measured. The Arrhenius line shows for the three rare gases the same slope, Q = 4 eV, which argues against the explanation of the rare gas diffusion by an interstitial lattice mechanism. (tr-auth)

14489 STUDY OF THE INFRARED SPECTRA OF POTASSIUM URANYL PENTAFLUORIDE AND AMMONIUM URANYL PENTAFLUORIDE. Brusset, Henry; Gillier-Pandraud, Helene; Nguyen Quy Dao (Ecole Normale Superieure, Paris. Faculte des Sciences, Paris). Compt. Rend., Ser. C, 265: 1209-11 (Nov. 27, 1967). (In French).

The infrared spectra of potassium uranyl pentafluoride and ammonium uranyl pentafluoride were determined in the regions from 4,000 down to 33 cm^{-1}, using various techniques and spectrometers. The attribution of the bands relative to the NH_4^+ ion was made and the results are tabulated. The attribution of the bands of the $UO_2F_5^{3-}$ was made by an analysis in normal coordinates. The calculations of the fourth constants were made and the results are tabulated. A detailed examination of the infrared spectra of the compounds $K_3UO_2F_5$ and $(NH_4)_3UO_2F_5$ showed that in passing from the first compound to the second the UO_2F^{3-} ion undergoes a slight deformation. (J.S.R.)

14490 EQUILIBRIUM OF REACTION BETWEEN URANYL IONS AND LACTIC AND TARTARIC ACIDS. Sobkowska, A. (Inst. of Nuclear Research, Warsaw). Rocz. Chem., 41: 1673-9(1967). (In Polish).

The complexing of uranium ions by lactic and tartaric acids was examined by polarographic and potentiometric methods. From the dependence of the UO_2^{2+} half-wave potential shift on the concentration of lactic acid the stability constant was determined as approximately equal to 300 $mole^{-1}$ l. The calculation of the stability constant from similar measurements carried out for UO_2^{2+} – tartaric system was impossible, because the function $E = f(\log[X_1])$ was nonlinear. The more precise results were obtained by potentiometric titration. The values of successive formation constants for complexes of uranyl ions with lactic acid are $\beta_1 = 250$, $\beta_2 = 45$, $\beta_3 = 15$ $mole^{-1}$ l. Based on these values the concentrations of individual complexes that depend on free ligand concentration were calculated. The results of similar measurements performed for UO_2^{2+} –tartaric acid system indicated the formation of polynuclear complexes, because the formation curves depend on the concentrations of UO_2^{2+} ions. (auth)

14491 ISOTOPIC EXCHANGE OF SOME AROMATIC FLUORINE COMPOUNDS WITH BASES. Zatsepina, N. N.; Tupitsyn,

I. F. (State Inst. of Applied Chemistry, Leningrad). Isotopenpraxis, 3: 269-75(July 1967). (In Russian).

Hydrogen in the aromatic C-H group of organic fluorine compounds exchanges rapidly with CH_3OH/CH_3OD at 50 to 180°C; the exchange of the hydrogen isotopes with NH_3/KNH_2 is rapid at temperatures above 0°C. (auth)

14492 PRODUCTION AND PROPERTIES OF VACUUM EVAPORATED FILMS OF THORIUM FLUORIDE. Heitmann, W. (Fernmeldetechnische Zentralamtes der Deutsche Bundespost, Darmstadt, Ger.); Ritter, E. Appl. Opt., 7: 307-9(Feb. 1968).

Experiments for the production of vacuum-evaporated films of thorium oxyfluoride showed that these films cannot be produced by direct evaporation of thorium oxyfluoride, because this material decomposes at approximately 1000°C into ThF_4 and ThO_2. ThF_4 evaporates at approximately 900°C and yields very stable films. The production of ThF_4 films is described, and the dispersion of the refractive index, the dielectric constant, and the useful range of high transparency are reported. Precautions for the handling of ThF_4, because of its radioactivity, are given. (auth)

14493 CHROMATOGRAPHY AND ZONE ELECTROPHORESIS OF INORGANIC IONS DISSOLVED IN FUSED SALTS. IV. ELECTROPHORETIC BEHAVIOUR OF INORGANIC IONS IN FUSED ALKALI NITRATES. Alberti, G.; Allulli, S.; Palazzeschi, L. (Univ., Rome). J. Chromatogr., 31: 519-22(Dec. 1967).

The electrophoretic behaviour of various metal ions dissolved in molten alkali nitrates has been investigated. The movement of the ions towards the cathode was found to decrease with electrical charge and decreasing ionic radius. Some bivalent and trivalent ions even showed anionic behaviour. This phenomenon has been related to the interactions with the nitrate ions. The effect of the cations of the molten solvent on the electrophoretic mobilities of the metal ions is also discussed. (auth)

14494 ALKALI COMPOUNDS OF TETRAKIS(2,2'-DIPYRIDYL)-URANIUM ($UDipy_4$): $LiUDipy_4 \cdot 3.5THF$ AND $Na_4UDipy_4 \cdot 8THF$. Herzog, Siegfried; Waicenbauer, Walter (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Chem., 7: 317-18 (Aug. 1967). (In German).

The reaction of metallic Li with $UDipy_4$ in THF (tetrahydrofuran) occurs with formation of a red-violet color and with the $UDipy_4$ gradually dissolving and black crystalline material taking its place; this material fits the analysis $LiUDipy_4 \cdot 3.5$ THF. On the addition of excess Li the material dissolves to form a green solution. It cannot be recrystallized. The behavior with Na under similar conditions is different; small violet-black crystals are deposited, which are capable of recrystallization from THF and fitting the analysis $Na_4UDipy_4 \cdot 8THF$. On heating this compound to 130°C at oil pump pressure THF is lost, and then Dipy at a higher temperature. The compounds decompose in air within a few seconds and are also sensitive to protonic solvents. (BBB)

14495 HIGH TEMPERATURE THERMODYNAMIC PROPERTIES OF RARE EARTH FLUORIDES. Chaudhuri, Asim Kumar. Houston, Tex., Rice Univ., 1967. 109p.

Thesis.

High-temperature enthalpies of the trifluorides of Ce, Pr, Nd, Gd, Dy, and Yb were determined by drop calorimetry. Encapsulated specimens were heated in a resistance-wound furnace and then dropped into the copper block calorimeter. The temperature of the furnace was measured by a Pt vs Pt-10% Rh thermocouple, while the temperature rise of the calorimeter was followed by a quartz thermometer. A description of various parts of the calorimeter is given, and errors and problems that may arise in such measurements are also discussed. The experimental data on these compounds are fitted to the standard equations and high-temperature thermodynamic functions are derived. The enthalpy of uranium monophosphide was measured in a tantalum container, which was dropped into a copper block calorimeter. (Disser. Abstr.) (TSS)

14496 CENTRAL-ION EXCHANGE REACTIONS OF RARE EARTH AMINOPOLYACETIC ACID COMPLEXES. I. Brucher, Erno; Szarvas, Pal (Kossuth Lajos Univ. of Sciences, Debrecen, Hungary). Magy. Kem. Foly., 73: 376-82(Aug. 1967). (In Hungarian).

The kinetic behavior of the complexes depends to a high extent on the number of carboxylate groups of the ligand coordinated to the central ion. Assuming that in the nonprotonated complexes all the carboxylate groups of the ligands are coordinated to the central ion, it may be concluded that in the protonated HNdEDTA and $HNdHEDTA^+$ complexes the ligands are coordinated to the Nd^{3+} ion by means of an imino-diacetate group. (JPRS)

14497 ESTIMATION OF METAL–OXYGEN BOND FORCE CONSTANTS OF TRANSURANYL IONS (NpO_2^{2+}, PuO_2^{2+}, AND AmO_2^{2+}) FROM THOSE OF URANYL ION IN VARIOUS MEDIA. Ohwada, Ken (Japan Atomic Energy Research Inst., Tokyo). Spectrochim. Acta, 24A: 97-102(Feb. 1968).

In order to estimate the apparent force constants of the metal–oxygen bond of transuranyl ions (NpO_2^{2+}, PuO_2^{2+}, and AmO_2^{2+}) in various media from those of uranyl ion in the same media, two approximate equations $K_{MO} = K_{UO} - 0.0100(Z_M - Z_U)^2$, and $K_{OMO} = K_{OUO} - 0.0075(Z_M - Z_U)^2$ were derived on the basis of data already published. Using these equations, the apparent M–O force constants of the transuranyl ions in various media were calculated, and some of the values obtained were compared with known data. It was found that these equations were very profitable for the estimation of the transuranyl force constants from the uranyl values. (auth) (UK)

14498 ^{14}CO ISOTOPIC EXCHANGE REACTIONS IN $Fe_3(CO)_{12}$ AND $Co_4(CO)_{12}$. Cetini, Giuseppe; Gambino, Olimpia; Sappa, Enrico; Vaglio, Gian Angelo (Univ., Turin). Ric. Sci., 37: 430-4(May 1967).

Kinetic studies of exchange between ^{14}CO and $Fe_3(CO)_{12}$ or $Co_4(CO)_{12}$ in benzene and n-heptane solutions at various temperatures are reported. In the two metal carbonyls all twelve CO groups exchanged at the same rate via a dissociation mechanism. The activation energy and entropy values for the exchange process are 27 ± 0.6 kcal-mole and +7 e.u. for $Fe_3(CO)_{12}$, and 28 ± 0.8 kcal-mole and +14.5 e.u. for $Co_4(CO)_{12}$ in benzene. The behavior for both compounds in the isotopic exchange reactions is interpreted on the basis of their structures. (auth)

14499 THE HYDROGEN-ELECTRODE REACTION IN THE ISOTOPICALLY MIXED SYSTEM. II. EVALUATION OF THE ELECTROLYTIC SEPARATION FACTOR OF DEUTERIUM FROM THE REST POTENTIAL OF THE HYDROGEN ELECTRODE IN THE DEUTERIUM-CONTAINING SYSTEM. Enyo, M.; Yokoyama, T. (Hokkaido Univ., Sapporo). Electrochim. Acta, 12: 1641-53(Dec. 1967).

The rest potential, E_r, of the hydrogen electrode in deuterium-containing hydrogen and a solution of light water as referred to the reversible hydrogen electrode in light hydrogen and the same solution is formulated as a function of deuterium content of the gaseous hydrogen and the deuterium separation factor, S_b, in the hydrogen ionization reaction. It was found that the relation is not significantly affected by the operative mechanism of the hydrogen-electrode reaction. Consequently, the relation provides a convenient method of evaluating S_b from the observation of E_r. Experiments were carried out on Pt, Ni, Au, and Ag in the system composed of deuterium-containing hydrogen and light water. The value of S_b as evaluated from E_r was practically independent of the deuterium content in the gaseous hydrogen. The values obtained were 1.1 for Pt in acidic and alkaline solutions, 1.6 for Ni in alkaline solution, 1.2 for Au and 1.5 for Ag, both in acidic solution. These values multiplied by the partition coefficient of deuterium between hydrogen and water (4.0 at room temperature) gave approximate values of the deuterium separation factor in the hydrogen evolution reaction. (auth) (UK)

14500 THE HYDROGEN-ELECTRODE REACTION IN THE ISOTOPICALLY MIXED SYSTEM. I. THE RELATION BETWEEN FORWARD AND BACKWARD UNIDIRECTIONAL RATES AND EVALUATION OF THE STOICHIOMETRIC NUMBER OF THE RATE-DETERMINING STEP. Enyo, M.; Yokoyama, T. (Hokkaido Univ., Sapporo). Electrochim. Acta, 12: 1631-9 (Dec. 1967).

A general consideration of the possible reaction routes of the hydrogen-electrode reaction leads to the classification of all the conceivable mechanisms into two groups according to the value of the stoichiometric number, ν, of the rate-determining step. The previous treatment on the validity, in the isotopically mixed system, of the relation between the forward unidirectional rate of the over-all reaction, V_f, its backward rate, V_b, the overpotential, η, and ν: $V_f/V_b = \exp(-2F\eta/\nu RT)$ was re-investigated rigorously on the basis of general considerations. It was found, in agreement with the previous conclusion, that this relation holds invariably, irrespective of the isotope content and of the magnitude of the isotope effect, provided that V_f and V_b are replaced by the respective sums of contributions of both isotopes, and η by the potential of the test electrode referred to its rest potential in the same isotopically mixed system. Based on the relation thus verified, a method is advanced that enables experimental determination of ν by combining the rate of isotopic exchange with the polarization resistance of the electrode used as the catalyst, without neglecting the isotope effect, and also the magnitude of the isotope effect from similar data. For the hydrogen-electrode reaction on nickel in an alkaline solution, ν has been determined to be 1.0, and the deuterium separation factor in the hydrogen ionization reaction to be 1.5. (auth) (UK)

14501 METAL CHELATES OF LANTHANOIDS IN AQUEOUS SOLUTION AND THEIR ANALYTICAL APPLICATIONS. Sangal, S. P. (Univ. of Allahabad, India). J. Prakt. Chem., 36: 126-37 (Sept. 1967).

A detailed study was made of the composition, stability, and analytical applications of rare earth chelates with Aluminon, Chrome Azurol S, Thoron, Chromotrope 2B, and Alizarin Red S. The composition of the chelates was ascertained spectrophotometrically using the method of continuous variations, mole ratio method, and the slope ratio method. The range for adherence to Beer's law, sensitivity, and optimum conditions required in analytical applications are also described. The Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu chelates with Aluminon all had a 1:1 composition and were stable in the 4.5 to 8.0 pH range. The structure of the lanthanoid Aluminon chelate is diagrammed. The chelation occurs between the phenolic and adjacent carboxylic oxygens, as determined on the basis of the liberation of hydrogen ions as a result of chelation. (BBB)

14502 INFRARED SPECTRA OF URANYL NITRATE COMPLEXES WITH HETEROCYCLIC AMINES. Kopashova, I. M.; Skutov, I. K.; Umreiko, D. S.; Shamanovskaya, R. I. (Belorussian State Univ., Minsk). Zh. Neorg. Khim., 12: 3304-6 (Dec. 1967). (In Russian).

Following earlier findings on the strong effect of the medium surrounding the UO_2^{2+} ion on the spectra of uranium compounds, the effects of secondary factors on the infrared spectra of uranyl nitrate complexes with pyridine and its derivatives, such as α-picoline, α-benzylpyridine, dipyridyl, and 1,10-phenanthroline, were investigated. The study was limited to the wavelengths of the uranyl ion and of the coordinated ONO_2^- group. Compounds with pyridine and dinitratoaquopyridine substituted with picoline and α-benzylpyridine possessed a frequency of 924 and 921 cm^{-1}, respectively, reduced from the original 930 cm^{-1} value for $\gamma(UO_2^{2+})$; no changes were noted in the antisymmetric valence vibration of the ONO_2^- group. From the donor–acceptor criteria between ligands and metal atoms, it was concluded that the uranium nitrate group represents a stable configuration. The frequency change of the valence vibrations of the UO_2^{2+} group is probably due to the interaction of the substitution groups with the oxygens of the uranyl group. Substitution of the water molecules in the dinitratoaquopyridine to form dynitratodipyridine uranyl enhances the covalent character of the uranium nitrate group in these compounds. Replacement of the unidentate pyridine and its derivatives by the bidentate dipyridilyl and phenantroline results in the increase of the antisymmetric valence vibrations to 940 and 942 cm^{-1}, respectively, indicating a strengthening of the U–O bond. (TTT)

14503 ON THE SPECTRAL BEHAVIOR OF THE CESIUM URANYL NITRATE CRYSTAL. Newman, John Brown. Baltimore, Johns Hopkins Univ., 1966. 211p.

Thesis.

The polarized infrared absorption spectrum of the cesium uranyl nitrate crystal at low temperature is reported for the 4 to 20μ region and compared with the visible fluorescence spectrum. As a basis for interpreting the electronic and vibrational spectra of the crystal, the ground state molecular orbital hierarchy was estimated from new overlap calculations, and the allowed transitions was tabulated from symmetry arguments. Consideration is given to both the isolated and trigonally coordinated uranyl complexes, using weak and strong spin-orbit coupling schemes, and to the interaction between the two trinitrato-uranyl groups in the unit cell of the crystal. Several features of the visible spectra, whose basis was obscure heretofore, may be accounted for by these results. These include: the observed polarizations of the absorption spectra, the observed Zeeman effect, the relative strengths of the three strongest fluorescence lines, and the role of the nitrato vibrations in the fluorescence spectra. The spin-orbit interaction is shown from these models to be comparable to, or greater than, the electronic electrostatic interaction within several excited uranyl configurations. Supporting its assignment as the uranyl bending fundamental, a vibrational mode at 213 cm^{-1} was observed in a number of combinations with the other fundamentals. The splitting of four nitrato modes, found first in the fluorescence spectra, are shown in the infrared spectra for the first time. (Disser. Abstr.)

14504 STUDIES OF SECONDARY DEUTERIUM ISOTOPE EFFECTS. Klein, Harvey Sheldon. Berkeley, Calif., Univ. of California, 1963. 159p.

Thesis.

The effect of D substitution on acidities of a series of carboxylic acids was studied. It is shown that the experimental secondary D isotope effects can be correlated with the difference in electron-donating abilities of H and D reflected by differences in dipole moments of a C–H and C–D bond. The solvolysis of specifically deuterated benzhydryl chlorides did not give an anticipated predominance of effect from the ortho and para positions; however, the rates can be rationalized in part on the basis of inductive effects. Several other studies are discussed. (Disser. Abstr.)

14505 HYDROGEN, ISOMERIZATION AND EXCHANGE REACTIONS ON PARTIALLY ACTIVATED CHROMIUM OXIDE CATALYSTS. Haller, Gary Lee. Evanston, Ill., Northwestern Univ., 1966. 125p.

Thesis.

Hydrogenation and double bond isomerization of 1-hexene at 64°C and isotopic exchange between deuterium and toluene at 110°C were studied on chromium oxide gel catalysts activated in hydrogen at temperatures between 200 and 400°C. The reaction products of 1-hexene deuterogenation and isomerization were separated chromatographically and the isotopic distributions determined mass spectrometrically. The isotopic distributions in the ring and in the methyl group of toluene were determined by a combination of NMR and mass spectrometric analyses. The relative rates of exchange of the ortho, meta, and para ring positions of toluene were determined from infrared spectra. With activation temperatures in the range from 200 to 300°C, the resulting hexane and 2- and 3-hexenes were extensively isotopically exchanged. As the activation temperature was increased to 400°C, multiple exchange became increasingly less important and following 400°C activation the 2-hexenes were nearly 100% d_0 and the hexane was about 90% d_2. Infrared analyses and mass spectrometric fragmentation patterns of the dideuterohexane indicated that it was predominately 1,2-dideuterohexane, although the presence of a small amount of 2,2-dideuterohexane was also indicated. The mechanisms of the reactions are discussed; a 1-3 intramolecular hydrogen transfer mechanism is proposed for the double bond isomerization. The rate of exchange of methyl was greater than that of the ring of toluence over the whole activation temperature range from 200 to 400°C; both rates passed through a maximum at about 330°C. More than one hydrogen atom of the methyl group may exchange during one period of adsorption, but only one hydrogen atom of the ring exchanges during one period of adsorption. Meta and para exchanged more readily than ortho hydrogen atoms. During activation at temperatures greater than 300°C, the presence of hydrogen promoted the formation of crystallites of α-chromia, but activation in helium left the material amorphous. In the early phase of this research, the extent of crystallinity was determined from x-ray diffraction powder patterns; later the extent of crystallinity could be estimated from the far infrared spectrum of the catalyst. The formation of crystallites of α-chromia increased the rate of double bond isomerization relative to that of hydrogenation of 1-hexene. Thus, in hydrogenation on a catalyst estimated to be 30% crystalline after activation at 400°C in hydrogen, the residual hexene was an equilibrium mixture of 1-, 2-, and 3-hexenes. A catalyst activated at 400°C in helium was completely amorphous and the residual hexene was predominantly 1-hexene. The activity of the chromia gel for exchange of both methyl and ring of toluene decreased with increasing crystallinity. This was not merely an effect of the decrease in total surface area since the rates of hydrogenation and double bond isomerization increased on the same catalysts. The rate of methyl exchange always exceeded that of ring exchange below 350°C, but ring exchange became increasingly favored and in some cases predominated above 350°C if the chromia gel remained amorphous. That is, methyl group exchange was favored by increased crystallinity relative to ring exchange of toluene at higher activation temperatures. (Disser. Abstr.)

14506 STUDIES ON THE MECHANISM OF ISOMERIZATION AND ^{18}O EXCHANGE IN GLYCEROPHOSPHORIC ACID. Fordham, William David. New Haven, Yale Univ., 1967. 118p.

Thesis.

Esters of orthophosphoric acid that have a hydroxyl group in the position beta to the phosphate will isomerize in acid solution to an equilibrium mixture of isomers. The isomerization was believed to proceed by esterification of the phosphate group to form a cyclic phosphate diester, which is easily hydrolyzed to mixtures of isomeric phosphates. The mechanism of acid to catalyzed isomerization was investigated by a kinetic study of the migration of the phosphoryl group of glycerophosphoric acid. Apparent first order rate constants were determined for the isomerization, and the activation energy was obtained from measurements of the temperature dependence of the rate of isomerization. An increase in acid concentration caused an increase in the rate of isomerization. The rate of isomerization is also increased by changing the solvent from H_2O to D_2O, indicating that the protonation of glycerol monophosphates occurs prior to the formation of the transition state. The rate of acid-catalyzed hydrolysis of glycerophosphoric acid is about one thousand times slower than the rate of isomerization under similar conditions. This difference in rates is due

mostly to the difference in apparent activation energies. The rate of exchange of ^{18}O from the solvent water into glycerophosphoric acid was measured. These data were combined with the isomerization rate data to indicate that isomerization occurs by two pathways; the first requiring the formation and subsequent hydrolysis of a cyclic phosphate diester; the second via a transition state in which the cyclic diester is not formed. A mechanism based on these results is proposed, and the corresponding kinetic equations were derived for the calculation of rate constants for the two pathways. (Disser. Abstr.)

14507 THE FAR INFRARED SPECTRUM OF SEVERAL SALTS OF QUADRAVALENT URANIUM. Stafsudd, Oscar Magnus Jr. Los Angeles, Univ. of California, 1967. 86p.

Thesis.

The frequencies of the fundamental infrared active lattice modes of several salts of U^{4+} were determined and the frequencies compared with those determined by vibronic spectra of the same salts. The infrared frequencies range from 50 cm^{-1} to 250 cm^{-1}. In order to make these measurements, a far infrared spectrometer was constructed. The spectrometer is useful over the range 25 cm^{-1} to 500 cm^{-1} and provides a resolution of at least 1 cm^{-1}. The salts investigated were Cs_2UBr_6, Cs_2UCl_6, and $[(C_2H_5)_4N]_2UCl_6$. Each of these salts have the uranium ion situated in the center of an octahedral complex of halogen ions. Two odd modes of this complex are infrared active and were observed both in vibronic and infrared spectra. These observations were generally in good agreement. Another off mode of the complex in the vibronic spectra ($^3\Gamma_{5u}$) was absent in the far infrared spectra in accordance with the selection rules. The lowest frequency odd mode of the lattice can be described as the uranium halogen complex moving approximately as a ridged unit against its neighbors. This mode is also infrared active and was observed directly in the infrared and indirectly in vibronic spectra. These frequencies did not correspond closely as had the former frequencies. The interpretation given is that in the vibronic spectra, those portions of k-space with high density of states, other than k = 0, are important. (Disser. Abstr.)

14508 MECHANISMS OF REACTIONS OF BUNTE SALTS AND RELATED COMPOUNDS. I. ACID HYDROLYSIS OF SODIUM ARYL SULFATES. II. ACID HYDROLYSIS OF BUNTE SALTS (S-ALKYL AND S-ARYL THIOSULFATES). Anderson, James Morley. Corvallis, Oreg., Oregon State Univ., 1967. 92p.

Thesis.

The mechanism of the acid hydrolysis of sodium aryl sulfates was investigated. The following reaction is proposed: $ArOSO_3^- + H_2O \xrightarrow{H^+} ArOH + HSO_4^-$. The study involved determination of the solvent isotope effect, the dependence of hydrolysis rate on acidity of the medium, and the response of rate to changes in dioxane content in dioxane-water mixtures for the acid-catalyzed hydrolysis of sodium phenyl sulfate. The experimentally determined solvent isotope effect, $k_{D_2O}/k_{H_2O} = 2.43$, lies in the range, $k_{D_2O}/k_{H_2O} = 1.9$ to 2.6, of values normally associated with A-1 hydrolysis mechanisms. A plot of the logarithm of $k\psi$ for the hydrolysis of sodium phenyl sulfate in aqueous hydrochloric acid solutions versus the Hammett acidity function, $-H_0$, gives a linear plot with a slope of 0.99. The effect of dioxane content on the rate of hydrolysis of sodium phenyl sulfate was determined at a fixed strong acid concentration for 40, 60, and 80% dioxane–water mixtures. An increase in the dioxane content from 40 to 80% increased the rate of hydrolysis by a factor of 67. The experimental results for the acid-catalyzed hydrolysis of sodium phenyl sulfate are compared with those for a closely related reaction, the acid-catalyzed hydrolysis of sodium methyl selenate. In each case the data suggest that the mechanisms of the two hydrolyses are different and that the hydrolysis of the aryl sulfate involves an A-1 mechanism. An explanation is offered as to how the hydrolysis of sodium aryl sulfates can occur via the A-1 mechanism and yet still exhibit the dependence of rate on aryl group structure that is observed. This same explanation also accounts for the fact that aryl sulfate ions hydrolyze much faster than alkyl sulfate ions. Seven different substituted aryl Bunte salts were prepared and kinetic studies of their acid hydrolysis were carried out in dioxane–water–$HClO_4$ mixtures. The following reaction is proposed $ArSSO_3^- + H_2O \xrightarrow{H^+} ArSH + HSO_4^-$. The hydrolysis rates of the aryl Bunte salts are best correlated by σ constants with a ρ of about -0.6. This indicates that the electron density on the sulfenyl sulfur, Ar-S-, is somewhat lower in the transition state of the rate-determining step than in the starting Bunte salt. The alkyl Bunte salts hydrolyze at essentially the same rate as does the phenyl Bunte salt. An A-1 mechanism is suggested for the Bunte salt hydrolysis. The fact that the Bunte salt hydrolysis and the aryl sulfate ion hydrolysis occur via the same A-1 type mechanism yet exhibit different structural effects is discussed and an explanation is presented to account for the fact that they show this somewhat different response of rate to changes in structure. (Disser. Abstr.)

14509 α-SECONDARY ISOTOPE EFFECTS ON THE REACTION CATALYZED BY FUMARASE AND SALT EFFECTS ON FUMARASE. Schmidt, Donald Emil Jr. Pasedena, Calif., California Inst. of Tech., 1967. 137p.

Thesis.

The α-secondary isotope effect of L-malic-2-T-1, 4-^{14}C acid on the reaction catalyzed by fumarase was determined. Evidence was presented which indicated that the reaction proceeded by formation of a carbonium ion in a rate determining state at C-2 which possesses little sp^2 character. The effects of sodium bromide and sodium phosphate at pH 7.3 and 27°C were determined. A partial kinetic and mechanistic scheme was developed to explain these effects. (Disser. Abstr.)

14510 METHOD OF REMOTE STARTING OF EXOTHERMIC CHEMICAL REACTIONS FOR THE PRODUCTION OF URANIUM. Delange, Maurice; Huet, Henri (to Commissariat a l'Energie Atomique). U. S. Patent 3,356,492. Apr. 27, 1959. Priority date May 2, 1958, France.

A method of remote starting of an exothermic chemical reaction for preparing metallic uranium is described. A small portion of a reaction mixture of uranium tetrafluoride is mixed with a small quantity of an alkaline or earth-alkaline peroxide, a small portion placed in a detonator, a reaction mixture of uranium tetrafluoride is placed in a vessel, an inert atmosphere or vacuum is provided in the vessel over the reaction mixture, and then the small portion of reaction mixture is ignited in the vessel and the ignited portion shot into the reaction mixture in the vessel by detonation of the detonator into the vessel. (Offic. Gaz.)

14511 PREPARATION OF A THORIA SOL BY HEATING AN AQUEOUS SOLUTION OF A THORIUM SALT IN AN AUTOCLAVE. Fitch, Frederick T.; Smith, Jean G. (to W. R. Grace and Co.). U. S. Patent 3,356,615. Filed Nov. 2, 1964.

A process for preparing a stable thoria sol is described, which comprises preparing an aqueous solution of a soluble thorium salt, heating the solution in an autoclave for a time and at a temperature sufficient to form a sol, removing the sol from the autoclave, reducing the electrolyte content, concentrating to the desired level, and finally recovering the product sol. (Offic. Gaz.)

14512 THE REMOVAL OF RADIONUCLIDES FROM WATER BY HYDROUS FERRIC OXIDE. McLellon, Waldron Murrill. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 374p.

Thesis.

Colloidal properties of hydrous ferric oxide, prepared under a variety of system conditions, were investigated. Additionally, the use of hydrous ferric oxide in the removal of radioactive solution ions was examined, using $^{137}Cs^+$, $^{22}Na^+$, $^{131}I^-$, and ^{35}S (SO_4^{2-}). Removal of radioactive ions was correlated with pH and with the electrokinetic properties of the colloidal particles formed. Two methods, with several system variants, were used to form the oxide. Electrophoretic mobility of hydrous ferric oxide particles produced was measured in a Briggs cell and correlated with pH and removal of radioactive ions. Results were correlated with a colloid micelle model based on present theory and the nature and location of ion placement on adsorption in the micelle were examined. The maximum $^{137}Cs^+$ removal was 2.1%, the maximum sodium removal 1.3%. These occurred at maximum negative electrophoretic mobility. Prespike and postspike cesium removal results were similar. The maximum $^{131}I^-$ removal was 40% at pH 4.0. Prespike and postspike removal data for $^{131}I^-$ were similar. Iodide removal using a $FeCl_3$ coagulant conformed to a Freundlich isotherm for concentrations of 10^{-13} to 10^{-7} molar. The maximum $^{35}S(SO_4^{2-})$ removal was 9.4% at pH 4.0. A linear relation was found to exist between cation removal and electrophoretic mobility of hydrous ferric oxide particles with a sharp break occurring at the pH of change from stable colloid to flocculent state (pH 9–10). Cation adsorption in a colloidal micelle of negative electrophoretic mobility was indicated to occur by ion exchange with other cations in the ionic layers external to the potential determining layer. Entry of anions other than hydroxyl ions into the potential determining layer of the micelle was also noted. Modifications to the micelle model are proposed. X-ray diffraction spectra were obtained for hydrous ferric oxide samples, freshly prepared, at pH values of 5 to 12. Spectra indicated an amorphous structure for all samples. (TSS) (Disser. Abstr.)

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Refer also to abstracts 14426, 14482, 14893, and 16356.

14513 (BNL–50057, pp 60–78) CHEMISTRY. (Brookhaven National Lab., Upton, N. Y.).

Research progress is reported on high-energy nuclear reac-

tions, nuclear spectroscopy, collision processes, the Brookhaven Solar Neutrino Experiment, chemical crystallography, isotope effects, inorganic reactions in solutions, hot-atom chemistry, radiation chemistry, gaseous ion chemistry, theoretical organic chemistry, and investigations of archaeological and historical materials. (M.C.G.)

14514 (COO-1528-18) RADIATION CHEMISTRY OF FROZEN AQUEOUS SOLUTIONS. Kevan, Larry (Kansas Univ., Lawrence. Dept. of Chemistry). Dec. 1, 1967. Contract AT(11-1)-1528. 99p. (CONF-671212-1). Dep. CFSTI.

From 19th Farkas Memorial Symposium, Jerusalem, Israel.

Radiolysis of pure ice, alkaline ice glasses, acid ice glasses, and solute-containing glasses is reported. Topics covered include: identification of trapped intermediates, EPR spectra, decay of intermediates, yields of radiolytic products, isotope effects, scavenger effects, phase effects, thermal decay, and hole reactions. (M.C.G.)

14515 (COO-1614-1) KINETICS OF SECONDARY REACTIONS IN IRRADIATED POLYETHYLENE. Final Report, May 1, 1966-August 31, 1967. Bodily, David M. (Arizona Univ., Tucson. Dept. of Chemistry). Feb. 2, 1968. Contract AT(11-1)-1614. 21p. Dep. CFSTI.

Chemical reactions occurring in polyethylene and other polymers during and subsequent to irradiation with ionizing radiation were studied to determine the mechanisms of these reactions. The decay of vinyl and vinylene groups was markedly suppressed at low temperatures. The rate of decay at 77°K was about 48% the rate at 298°K. The rate of decay of these groups was also reduced for irradiations of greater linear energy transfer. For proton irradiations, the rate was about 34% of the rate for electron or gamma irradiations. For alpha particle irradiations, the rate was about 18% of the rate for gamma irradiations. The rate of formation of vinylene and vinyl groups was only slightly affected by temperature, linear energy transfer, or phase. In cis-polybutadiene, the rate of cis-trans isomerization was nearly independent of temperature, but the rate of disappearance of unsaturation at 77°K was only 42% of the rate at 298°K. Crosslinking showed a temperature dependence similar to that of vinyl and vinylene group decay, but the relationship between the two processes was not clear. Nitric acid oxidation of irradiated polyethylene showed that vinyl groups are primarily in amorphous areas that are easily oxidized. Vinylene groups are formed throughout the crystalline and amorphous regions and are more resistant to oxidation. Conjugated diene groups are formed to a greater extent in high-density polyethylene than in low-density polyethylene, but are easily oxidized. This is interpreted to mean that they are formed throughout the polymer, but cause disruption of crystalline regions, making them accessible to oxidation. Allyl and conjugated polyenyl-free radicals are trapped during irradiation in vacuo at 77°K. Their concentrations increase during warming of the sample subsequent to irradiation. The concentration of the allyl radical decreases and the concentration of polyenyl radicals increases on ultraviolet irradiation at 77°K of electron-irradiated samples. These reactions indicate the migration of reactive species in the solid sample. (auth)

14516 (NP-17265) THE CROSS-LINKING AND CHARACTERISATION OF PHENYL CONTAINING SILICONE RUBBERS. Kay, Edna; Thomas, D. K. (Royal Aircraft Establishment, Farnborough (England)). Aug. 1967. 25p. (RAE-TR-67182). Dep.

Acceptable levels of cure can be achieved in phenyl methyl silicone rubbers by the use of organic peroxides or high-energy irradiation. With peroxides the efficiency of the crosslinking reaction is very low, and therefore high concentrations of reagent must be used. Irradiation with β or γ rays is an attractive method because of the linear relationship that exists between crosslink density and integrated dose. Using irradiation techniques it is possible to achieve any desired level of crosslinking in a controlled manner. Characterisation of phenyl silicone vulcanisates is readily carried out by solvent swelling methods. (auth) (UK)

14517 (ORNL-TM-2083) FINAL PURIFICATION OF THE HEAVY ACTINIDES FROM THE FIRST FOUR CAMPAIGNS OF THE TRU PROGRAM. Baybarz, R. D.; Orr, P. B. (Oak Ridge National Lab., Tenn.). Nov. 20, 1967. Contract W-7405-eng-26. 31p. Dep. CFSTI.

Special glassware equipment was fabricated to isolate the transplutonium elements from the first four campaigns of the TRU program. The processing included LiCl-anion exchange for inner actinide group separation, chromatographic elution from a cation-exchange column for Cf isolation, and solvent extraction for berkelium purification. A total of 76 grams of ^{244}Cm was processed to recover 2.3 mg of ^{252}Cf and 0.2 mg of ^{249}Bk. (auth)

14518 (ORO-2418-4) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Research Report, 1967. Sears, W. C. (Georgia Univ., Athens. Dept. of Physics). Dec. 19, 1967. Contract AT(40-1)-2418. 22p. Dep. CFSTI.

Since molar absorptivity for the trans-vinylene band in trans-1,4-polybutadiene was found to change with temperature, a study of it was begun to determine applicable absorptivities for analysis of irradiated polymers whose spectra were measured at high temperatures to eliminate crystallinity. Molar absorptivity dropped sharply at 46°C in changing from crystalline modification I to II. Applicable trans-vinylene absorptivities for analyzing irradiated Neoprenes may be evaluated from the Neoprene polymers themselves or from values obtained from trans-1,4-polybutadiene. Different O-ring polymers were tested to improve their permanent set and hot extrusion which resulted in gasket leaks around the salt windows on cooling the helium-filled absorption cells to room temperature. Viton-A and live silicone rubber O-rings spring loaded to compensate for plastic flow provided the most satisfactory solution. A dose of 18×10^8 RAD produced strong new bands in poly-2-vinylpyridine at 2350, 2068, 2000, 1618, and 1536 cm^{-1}. The 2068 and 2000 cm^{-1} bands suggest formation of allenes. None of these new bands were found in the 75/25 butadiene/2-methyl-5-vinylpyridine copolymer after irradiation. The radioinduced changes in the copolymer after doses up to 9.8×10^8 RAD appeared to be confined to the butadiene fraction. (auth)

14519 (CEA-tr-R-1907) BOUCLE DE CIRCULATION EXPERIMENTALE POUR L'ETUDE DES PROCESSUS DE POST-LUMINESCENCE DES SOLUTIONS IRRADIEES DE PROTEINES, D'ACIDES AMINES, DE COLORANTS ET DE POLYMERES SYNTHETIQUES. (Experimental Circulation Loop for Study of Post Luminescence of Irradiated Solutions of Proteins, Amino Acids, Dyes, and Synthetic Polymers). Sapezhinskii, I. I. Translated into French from Tr. Mosk. Obshchest. Ispyt. Prir., Otd. Biol., 16: 25-6(1966). 5p. (In French). CFSTI. JCL $1.10 fs, $0.80 mf.

The experimental circulation loop designed for study of post-luminescence of irradiated proteins, amino acids, dyes, and synthetic polymers is described. The installation has a liquid flowing through a cuvette where the liquid is irradiated and receiver arranged in the vicinity of the photocathode of an end-window photomultiplier. The construction of the thermostat recipients for measurements and irradiations is described. The kinetic curves of the post-luminescence of uv-irradiated eosin solutions and of x-irradiated trypsin and hemoglobin are given as examples. (J.S.R.)

14520 CHLORINE PRODUCTION BY GAMMA RADIOLYSIS OF ACID CHLORIDE SOLUTIONS AND ITS EFFECT ON ANALYTICAL PROCEDURES. Kubota, Hisashi (Oak Ridge National Lab., Tenn.). Anal. Chem., 40: 271-4(Feb. 1968). (ORNL-P-3467).

The gamma radiolysis of acid chlorine solutions generates free chlorine above critical acid and chloride concentrations. The deleterious effect of this chlorine generation can be greater in certain analytical procedures than the ordinary radiolytic effect. The amount of chlorine produced increases with increasing acid and chlorine concentrations. Thus, it is sometimes expedient to work at lower chloride and/or acid concentrations to minimize the effects of chlorine formation at the sacrifice of some other item. The experimental conditions used in this study were selected to simulate the conditions that are normally encountered in processing and analytical work. Mechanisms are proposed to explain the radiolysis. (auth)

14521 OIL-RESISTANT RUBBERS PRODUCED BY GAMMA-RADIATION-INDUCED GRAFT POLYMERIZATION OF ACRYLONITRILE AND THEIR VULCANIZATION WITH FUNDAMENTAL RECIPES. PART 1. GAMMA-RADIATION-INDUCED GRAFT POLYMERIZATION OF LATTICES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture); Syobayashi, Goro. Nippon Gomu Kyokaishi, 40: 91-9(Feb. 1967). (In Japanese).

NR or SBR latex was mixed with acrylonitrile (AN) by using emulsifiers and was irradiated with γ rays. Hundreds of grams of rubbers with different grafting ratios were thus produced. Two emulsifying procedures, adding AN to the latex which contains the emulsifier in advance and adding a mixture of AN and emulsifier to the latex, were adopted. The grafting effect on physical properties of grafted rubbers, their stocks and vulcanizates was greater when produced by the second procedure. On the other hand, NBR was blended with NR or SBR. The AN contents of blended rubbers were made equal to those of the grafted rubbers Some physical properties of blended rubbers, their stocks and vulcanizates vary in approximate proportion to blending ratio. In contrast, these properties of grafted rubbers, stocks and vulcanizates make sudden changes with increasing grafting ratio.

The vulcanizates from grafted polymers have, in general, higher resilience and lower oil resistance than those from the corresponding blended polymers. (auth) (NSA of Japan)

14522 DEAMINATION OF AQUEOUS GLYCINE-Cu. II. SOLUTION BY GAMMA RAYS. Ikeda, Toshio (Shizuoka Univ., Japan). Rep. Fac. Sci., Shizuoka Univ., 1: 13-18(Dec. 1965).

Gamma-induced deamination was studied on aqueous solutions of glycine–copper systems at pH 4.0, keeping the concentration at a constant 0.02M with regard to the glycine component. The $G(NH_3)$ value was measured on the following solution systems: Gl; $CuGl_2$; $CuGl_2 + CuSO_4$; $CuGl_2 + Gl$; $CuGl_2 + Gl + CuSO_4$; Gl + $CuSO_4$; where Gl = glycine and $CuGl_2$ = Bis(glycinato)copper(II). The curve of $G(NH_3)$ vs. the constitution of solution appeared in different fashions characteristic of the type of solution. Glycine was deaminated at a higher efficiency in the form of copper chelate than in the state of free molecule; copper sulfate was ineffective for the deamination reaction of $CuGl_2$, but seemed to be effective for glycine; $CuGl_2$ was effective for deamination of glycine, and the degree of deamination from the solution system appeared to be much higher than the sum of those expected by assuming additivity of $G(NH_3)$ values for its two constituents, Gl and $CuGl_2$. These results seemed to provide a possible indication for a certain interaction occurring between radicals inherent of both constituents, Gl and $CuGl_2$, on irradiation. Some qualitative interpretations were given by taking into consideration the role of the hydrated electrons. (NSA of Japan)

14523 ADSORPTION PROPERTIES OF γ-IRRADIATED ADSORBENTS AT LOW TEMPERATURES. Ermatov, S. E.; Turdybekov, I. T. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 43-7(Mar.-Apr. 1967). (In Russian).

Samples of Montmorillonite clays, zeolite, and silica gel were irradiated with gamma rays at temperatures from 0 to –150°C, and were tested for adsorption of air and oxygen at liquid nitrogen temperature. The adsorptive capacity of the clay remained as high as that of the silica gel. On raising the temperature to room temperature, adsorbed gaseous molecules in unirradiated samples were almost completely desorbed, while the adsorbed gaseous molecules in the irradiated samples were firmly bound to the surface and began to desorb at 110 to 120°C. The rate of additional absorption was a maximum in the first few moments of contact of the irradiated absorbent with the gas. At low temperatures the rate of additional adsorption increased significantly, and the amount of adsorption depended on the type of absorbent. This additional absorption by irradiated absorbents could be used to improve the vacuum in a system. (TTT)

14524 EFFECT OF SMALL DOSES OF GAMMA-RAYS AND NEUTRONS ON THE AGING OF OILS. Bazin, A. P.; Kaplan, S. Z.; Spirina, I. F. Khim. Tekhnol. Topliv Masel, No. 6, 21-3(1966). (In Russian).

The initiating action of gamma rays and neutrons on the aging of petroleum oils in contact with structural materials was studied. Results of experiments on the study of the influence of bremsstrahlung from a 25-MeV betatron on the dielectric properties of transformer oil in contact with active oxidation catalysts (copper and copper oxide), and the influence of fast neutrons (Po-Be) on the viscosity and oxidation number of turbine oil with and without a 5% addition of polyisobutylene during storage in steel containers are presented. The initiating dose amounted to 500 R. Transformer oil subjected to a short-term irradiation (475 rad) ages faster than nonirradiated oil during prolonged contact with copper or copper oxide in air. On irradiation with fast neutrons (10^9 n/cm^2) and subsequent prolonged storage of turbine oil with and without 5% polyisobutydene, the viscosity and the oxidation number remained practically unchanged. The turbine oil irradiated with neutrons (Po-Be) showed induced activity (beta-active isotopes ^{32}P and ^{35}S). (ATD)

14525 RESEARCH ACTIVITIES AT THE SWEDISH RESEARCH COUNCILS' LABORATORY AT STUDSVIK. Kinell, P.-O. (Forskningsradens Laboratorium, Studsvik, Sweden). pp 122-44 of Svensk Naturvetenskap. Afzelius, B. (ed.). [Stockholm], Statens Tekniska Forskningsrad, 1967. (In Swedish).

A survey is given of the research activities at The Swedish Research Councils' Laboratory at Studsvik. The research program covers problems within nuclear physics, structure chemistry, nuclear chemistry, radiation chemistry, agricultural chemistry, radiation biology, and medicine. In nuclear physics atomic nuclei, excited after neutron capture, were studied by γ and β spectroscopy. So far the γ spectra of ^{104}Rh and ^{168}Er and the conversion electron spectra of rare earth isotopes were studied. A nondestructive method for estimating the burnup and the production of plutonium in nuclear fuel elements was developed. It uses a γ spectrometer for intensity measurements on lines from ^{137}Cs and ^{106}Ru. A neutron diffraction set up was built to determine structure of chemical compounds. More than 20 compounds were studied, most of them as commission work. In nuclear chemistry the interest was focussed on threshold reactions and the possibilities to get carrier-free isotopes from such transformations. Stability of short-lived nuclides from fission reactions was studied by thermochromatography and mass separation. Radioinduced polymerization of various monomers in wood was studied. Another field was the electron spin resonance studies of free radicals formed in heterogeneous systems, e.g. hydrocarbons/silica gel, after γ-irradiation. The work in agricultural chemistry was concentrated on determination of copper in milk and milk fractions using activation analysis. A major subject in radiation biology was the dosimetry in plants. Thermoluminescence detectors in barley were used. The content of microelements in bone and teeth was determined by activation analysis. The dependence on milieu factors was studied. The distribution of microelements in various tissues was determined by autoradiographic techniques. The physiologic role of such elements was studied. It was found that vanadium has no inhibiting effect on caries or arteriosclerosis. (Sweden)

14526 YIELDS IN THE RADIATION DEGRADATION OF SOLID CARBOHYDRATES. Lofroth, Goran (Univ., Stockholm). Acta Chem. Scand., 21: 1997-2006(1967).

The degradation induced by γ-irradiation of various simple polycrystalline carbohydrates was studied by ESR measurements of the solid samples, and by analyses of product formation, and reactions occurring when the samples are dissolved in water. The area under the ESR absorption curve was not inversely proportional to the absolute temperature at which the ESR measurements were made, between 160 and 300°K, indicating a possible interaction between the radicals. When the irradiated carbohydrates were dissolved in water, they reacted consuming oxygen dissolved in the water. It is postulated that radical–oxygen and radical–radical reactions are competitive. The consumption of dissolved oxygen during the reaction was fit to an approximate equation from which the ratio of reaction velocities of radical–oxygen and radical–radical reactions was found to be in the range of 10 to 15. The G-value of oxygen consumption at high oxygen concentrations of the water was 4 or higher. The aqueous solutions of the irradiated carbohydrates contained compounds, possibly organic peroxides, that oxidized ferrous ions of the ferrous sulfate reagent. The G-value of ferrous ion oxidation was 4 to 10 for various carbohydrates. The yield of acids and the total degradation of the carbohydrates were strongly dependent on the crystalline form of the carbohydrate. (auth) (Denmark)

14527 SEPARATION OF ^{51}Cr BY MEANS OF THE SZILARD–CHALMERS EFFECT FROM POTASSIUM CHROMATE IRRADIATED AT LOW TEMPERATURE. Brune, Dag (Aktiebolaget Atomenergi, Studsvik, Sweden). Acta Chem. Scand., 21: 2087-94(1967).

The recombination of ^{51}Cr in K_2CrO_4 at low temperature as well as under dilute conditions was investigated. Crystals of K_2CrO_4 and a 1% solution of this compound were irradiated in a thermal column of a nuclear reactor. Lowering of the temperature caused a decrease in retention. Chemical separations were carried out both at 0 and at 20°C. The degree of enrichment was determined by reactivating one part of the solution after separation of the hexavalent chromium. Irradiation of K_2CrO_4 in the frozen aqueous solution was observed to favor the degree of enrichment. The fate of the ^{51}Cr recoil nuclide was discussed in the light of the thermal spike theory. (auth) (Denmark)

14528 REACTION INTERMEDIATES IN THE CHEMISTRY OF RECOIL CARBON ATOMS. Welch, M. J.; Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.). Chem. Commun., No. 3, 117-18(1968).

Energetic C-atoms, produced by nuclear recoil, react with simple hydrocarbons to form acetylene and ethylene in high yields. Addition of oxygen scavenger causes formation also of CO since C-atoms reaching thermal energies react preferentially with oxygen. The mechanism currently suggested for the former reactions involves insertion of a C-atom into C–H bonds to form carbene intermediates. Pressure dependence studies were made to investigate the single collisional deactivation of such intermediates. The ^{12}C(p,pn)^{11}C reaction was used as recoil C-atom source, utilizing the 1 to 3 GeV proton beam of the Brookhaven Cosmotron, and the products formed in the hydrocarbon samples were analyzed by conventional radio-gas chromatography techniques. Pressure trends for the scavenged cyclopropane system, in which acetylene is the only major hydrocarbon product, are shown graphically, together with recoil losses at the various pressures. The same pressure trends were observed in regions of high recoil loss as in low recoil loss, indicating that the observed trends were true pressure effects and not associated with a wall effect. Similar pressure trends were observed in scavenged propane, methane,

and neopentane systems. The observed pressure effects cannot be explained by the unmodified model of C-atom insertion. A model which is consistent with the results involves collision of an excited C-atom, leading first to a collision complex, where partial energy equilibration occurs between the attacking species and the hydrocarbon. This collision complex can decompose to an excited hydrocarbon molecule and a thermalized C-atom, or become stabilized to a true carbene intermediate which is the precursor of the final products. Pressure dependence is caused by the stabilization of the collision complex. (UK)

14529 ELECTRON ATTACHMENT TO DCl IN THE γ-RADIOLYSIS OF CYCLOHEXANE + DCl SOLUTIONS. Richards, J. T.; Scholes, G. (Univ. of Newcastle-upon-Tyne, Eng.). Chem. Commun., No. 24, 1261(1967).

Studies indicated that DCl can, at low concentrations, react with a precursor of hydrogen in irradiated liquid cyclohexane, which cannot be a thermal H-atom. This observation is compatible with an earlier proposal that electron attachment to suitable scavengers can occur in irradiated nonpolar systems. Since the formation of D atoms from DCl by dissociative capture of a thermal electron is endothermic to the extent of 0.7 eV, the electron attachment process may involve more than one DCl molecule; such association is suggested for electron capture by HCl both in the solid and gaseous phase. (UK)

14530 THE RESPONSE OF URACIL-2-^{14}C TO X-IRRADIATION UNDER NITROGEN AND OXYGEN AND TO TREATMENT WITH ASCORBIC ACID. Smith, Kendric C.; Hays, James E. (Stanford Univ., Palo Alto, Calif.). Radiat. Res., 33: 129-41 (1968).

The following compounds were produced when solutions of uracil-^{14}C were irradiated with x rays: dihydrouracil, 6-hydroxy-5-hydrouracil (under nitrogen but not oxygen), isobarbituric acid, cis- and trans-glycols of uracil, alloxan, alloxantin, and dialuric acid. When uracil was treated with ascorbic acid–$FeSO_4$, the results were similar in many respects to those obtained after x irradiation except that more dihydrouracil was produced relative to the more oxidized products (glycols, etc.), as compared to the results after x irradiation. Auto-irradiation of an aged sample of uracil-^{3}H also mimicked in certain respects the effect of x irradiation on uracil. The major products identified were the cis- and trans-glycols of uracil. (auth)

14531 RADIOCHEMICAL FORMATION AND PHOTOLYSIS OF α-KETO-OXETANE DERIVATIVES OF VINYLENE CARBONATE. Farid, Samir; Hess, Dieter; Krauch, Carl Heinrich (Max-Planck Institut fuer Kohlenforschung, Muelheim-Ruhr, Ger.). Chem. Ber., 100: 3266-72(1967). (In German).

Phenanthrenequinone, acenaphthenequinone, benzil, and benzophenone add to vinylene carbonate under selective photochemical excitation to give oxetane derivatives. When sensitized by solvent toward ^{60}Co γ radiation, phenanthrenequinone forms the same adducts with a series of olefins that it does photochemically. The olefins are vinylene carbonate, xanthotoxin, styrene, and 2,2-dimethylchromene. G values range from 0.8 to 3. The photolysis of the resulting oxetanes is also reported. Analogies between the photochemistry and radiation chemistry are emphasized. (BBB)

14532 DECOMPOSITION OF IODINE-LABELED ANTIPYRINE. Munck, O.; Andersen, Anne Marie (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 19: 256-8(1967).

Autoradiolysis of radioiodinated antipyrine was studied. The 4-iodoantipyrine-^{125}I(4-IAP-^{125}I) and 4-iodoantipyrine-^{131}I(4-IAP-^{131}I) used were purchased from The Radiochemical Centre, Amersham, England. The radioactivity for 4-IAP-^{125}I was 0.5 Ci/g and for 4-IAP-^{131}I about 1.0 Ci/g. Radiochemical purity was examined by paper chromatography using the eluent n-butanol–acetic acid–water (120:30:50 v/v). On the basis of the results, the following recommendations are made: preferably use the ^{125}I-labeled compound, dilute the compound with water and not with saline, analyze each batch for radiochemical purity, storage at the lowest convenient temperature is advisable, and purify the ^{131}I-labeled compound before use. (BBB)

14533 RADIOLYSIS OF COCONUT PARINGS OIL. Pascual, O. S.; Cunanan, S. A. (Philippine Atomic Research Center, Diliman). Philippines Nucl. J., 1: 63-9(Jan. 1967).

Commercial coconut pairings oil contain an appreciable amount of linoleic acid (5–7%) which makes it unsuitable for cooking purposes. Gamma radiation from a ^{60}Co source was used to preferentially polymerize the linoleic acid ester to reduce the amount to acceptable values (≤2%). There is an improvement in the physical appearance of the oil, and the oleic acid content was not affected appreciably. The resulting oil with almost twice the oleic acid content of desiccated-coconut oil should be nutritionally preferable to the latter. (auth)

14534 KINETICS OF THE γ-RAY HOMOGENEOUS POLYMERIZATION OF ACRYLONITRILE. I. THE DETERMINATION OF TRANSFER CONSTANTS. Vlagiu, I.; Paun, J. (Chemical Research Inst., Bucharest). Rev. Roum. Chim., 12: 1085-94 (Sept. 1967).

Ionizing radiation induced acrylonitrile polymerization in dimethylformamide (DMF), dimethylsulfoxide (Me_2SO), and ethylenecarbonate (EtC). The polymerization rate was proportional to $V_g = kI^{\alpha}[M]^{\beta}$ ($\alpha = 0.547$ and $\alpha = 0.542$; $\beta = 1.253$ and $\beta = 1.264$ for Me_2SO and EtC). The reaction kinetics are discussed on the basis of solvent and monomer radiolysis. The transfer constants at 30°; 40°; 50°; 60° of the respective solvents were determined, obtaining $C_{tr,s} \times 10^5 = 17.18$ and 32.40; 5.19 and 8.12; 3.14 and 5.14 and 5.11 for the mentioned solvents in the above sequence; the activation energies for each solvent were determined from the reaction values k_g: $E_{\alpha}^{DMF} = 14.76$ kcal/mole; $E_{\alpha}^{Me_2SO} = 14.68$ kcal/mole; $E_{\alpha N}^{EtC} = 14.92$ kcal/mole. (auth)

14535 INVESTIGATION OF THE RADIOLYSIS OF HIGH-POLYMER GLUCOSE. Markevich, S. V.; Bondarenko, N. T.; Kharamonenko, S. S.; Stakhovskii, E. V.; Gorbunov, P. T.; Gol'din, S. I. (Inst. of Physical and Organic Chemistry, Belorussian SSR. Belorussian Scientific Research Inst. of Blood Transfusion, Minsk). Radiobiologiya, 7: 504-10(1967). (In Russian).

Native dextran as a 6% aqueous solution and dry dextran were irradiated and the dry carbohydrate was then dissolved and made up to the same concentration. The viscosity, molecular weight, and yields of radiation products decreased with increasing dose. Electron paramagnetic resonance spectra revealed that the radiolysis proceeds through the formation of highly stable radicals. No changes in the infrared spectra resulted from irradiation. The previously observed peak at 265 to 275 millimicrons was preserved in both cases. Tests on mice, rabbits, and dogs showed that the radiolyzates were not toxic or pyrogenic. (JPRS)

14536 PREPARATIVE RADIOCHEMICAL HYDROXYLATION OF SUBSTITUTED PHENOLS IN AQUEOUS SOLUTION. Graesslin, Dieter; Merger, Franz; Schulte-Frohlinde, Dietrich; Volkert, Otto (Institut fuer Strahlenchemie, Karlsruhe, Ger.). Chem. Ber., 100: 3077-83(1967). (In German).

The γ irradiation of hydroxybenzoic acids in aqueous solution may be used as a preparative method for the introduction of a hydroxyl group on the ring, preponderantly in positions ortho to hydroxyl groups already present. Benzoic acid accepts up to 4 hydroxyl groups. Hydroxylation also suceeds when the COOH group is replaced by COR, COOR, CN, CHO, or NO_2; it was possible to prepare 2,3,4,5-tetrahydroxynitrobenzene from nitropyrogallol. Very low yields were found when no electron acceptor was substituted on the ring. The G-values are between 0.1 and 2.9; yield reached 50% in some cases. In the γ radiolysis of water, the products were hydrogen, hydrogen peroxide, solvated electron, hydrogen atom, and hydroxyl radical. To understand the process by which these species react with phenolcarboxylic acids and related compounds, dilute aqueous solutions of the compounds were subjected to ^{60}Co γ radiation and the products isolated and identified. (BBB)

14537 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PRAGUE, 1965. PART 5. Held Under the Auspices of the International Union of Pure and Applied Chemistry, Prague, August 30–September 4, 1965. J. Polym. Sci., Part C, No. 16, 2477-3078(1967). (CONF-650801–(Pt.5)).

Fifty-eight papers presented at the symposium are included. Separate abstracts were prepared for 7 papers. (M.C.G.)

For abstracts of individual papers see: 14538–14544.

14538 γ-RADIATION-INITIATED POLYMERIZATION OF N-VINYLSUCCINIMIDE IN THE LIQUID AND SOLID STATES. Hardy, Gy.; Varga, J.; Nagy, G.; Cser, F.; Ero, J. (Technical Univ., Budapest). J. Polym. Sci., Part C, No. 16, 2583-96(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

The γ-radioinitiated polymerization of NVSI in both the liquid and solid phases proceeds according to a radical mechanism. Polymerization rate and molecular weight of the product are higher in the liquid phase than in the solid phase. A number of features characteristic of monomers polymerizing according to accelerated kinetics can be demonstrated on the model of NVSI, which in many respects behaves similarly to acrylic amide. Kinetical data, the polymer formed and the accelerating effect of inert additives, the amorphous structure of the polymer formed, the high activation energy of polymerization as well as the isotropic ESR spectrum of the assumed growing radical, are all findings that prove that in the course of growth the monomer molecule must leave the crystal lattice, that is, that the geometry of the crystal lattice does not favor polymerization. (auth)

14539 INVESTIGATION IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XII. γ-RADIATION-INITIATED COPOLYMERIZATION OF ACRYLIC ACID AND ACRYLIC AMIDE IN THE SOLID, LIQUID, AND SUPERCOOLED LIQUID PHASE. Hardy, Gyula; Nagy, Lajos (Research Inst. for the Plastics Industry, Budapest). J. Polym. Sci., Part C, No. 16, 2667-73(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

The phase diagram of the acrylic amide–acrylic acid solid system is characterized by two eutectic compositions and by a molecular compound of 1:2 mole proportion with a maximum melting point. In the solid phase the rate of the copolymerization is the highest at the eutectic composition and passes through a minimum at the composition of the molecular compound. The composition of the copolymer formed in the solid phase reflects the structure of the solid phase and differs from the composition determined by the relative reactivity constants. In the supercooled liquid-phase copolymerization proceeds at a higher rate than in the solid phase and probably according to an ionic mechanism. (auth)

14540 INVESTIGATION OF THE RADIATION POLYMERIZATION BEHAVIORS IN THE SUPERCOOLED LIQUID AND MESOMORPHOUS PHASE. Hardy, Gy.; Fedorova, N.; Kovacs, G.; Boros-Gyevi, J. (Research Inst. for the Plastics Industry, Budapest). J. Polym. Sci., Part C, No. 16, 2675-80(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

Polymerization of N-vinylcaprolactam, dimethyl itaconate, and vinyl chloroacetate proceeds more rapidly in the supercooled liquid phase than in the solid phase. The effect is greater when supercooling is slow than when the process of supercooling is rapid. This phenomenon might be explained by the prearrangement of the monomer molecules without being fixed in the crystalline solid phase, such prearrangement being favorable from the viewpoint of polymerization. For monomers that polymerize near their melting point at a maximum rate, the presence of an even more ordered mesomorphous phase, similar to the liquid crystalline state, is assumed. (auth)

14541 RADIOCHEMICAL COPOLYMERIZATION OF STYRENE WITH ACRYLONITRILE IN VARIOUS MEDIA. Chapiro, Adolphe; Jendrychowska-Bonamour, Anna-Maria (CNRS, Bellevue, France). J. Polym. Sci., Part C, No. 16, 3003-9(1967). (In French).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

The radiochemical copolymerization of styrene (St) and acrylonitrile (AN) was studied in bulk at 0, 20, and 50°C; in dimethylformamide (DMF) solution at –78°C; and in diisodecyl adipate mixture forming a gel at –78°C. The copolymerization in bulk was investigated over a wide range of radiation intensities. The intensity exponent, excluding AN-rich systems where kinetics were disturbed by polymer precipitation, was 0.5. The variation of rate and copolymer composition with initial feed composition corresponds to the relations obtained in classical free-radical initiation. At 0°C the copolymers formed were higher in styrene content, indicating the contribution of a cationic mechanism. In solutions of the two monomers in DMF it was possible after irradiation at –78°C to separate by precipitation by methanol a polymer consisting of practically pure polyacrylonitrile and a waxy residue containing St and AN. In this system an anionic polymerization leading to PAN and a free-radical reaction yielding low molecular weight copolymers are observed to occur simultaneously. In the rigid medium formed by the mixture of monomers and diisodecyl adipate at –78°C the reaction is very fast. Kinetics of this copolymerization were analogous to those of the reaction in bulk at higher temperatures. The compositions of the copolymers obtained confirm the free-radical mechanism of the process. The rate of this reaction and the fact that in spite of the very low temperature high-molecular-weight polymers were obtained were interpreted by assuming a very low chain termination rate in this medium. (auth)

14542 RADIOCHEMICAL POLYMERIZATIONS AND COPOLYMERIZATIONS IN GLASSY MEDIA AT LOW TEMPERATURE. Chapiro, Adolphe; Roussel, Daniel (CNRS, Bellevue, France). J. Polym. Sci., Part C, No. 16, 3011-20(1967). (In French).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

It was shown previously that methyl methacrylate (MMA) does not polymerize in the crystalline state; it can, however, be polymerized when it is irradiated at low temperature in solid suspension in paraffin oil. This reaction was extended to other monomers: vinyl chloride (VCl), acrylonitrile (AN), and styrene (St) and to other glassy media. The irradiations were carried out with ^{60}Co γ rays at –78 and –196°C; methyl methacrylate was irradiated in solid solution in two mixtures of normal paraffins, which were crystalline at low temperature. The polymerization was very slow. In a mixture of diisodecyl adipate that formed a gel at –78°C, the reaction was very rapid, and more rapid than in paraffin oil. The molecular weights of the polymers were also higher. VCl was also polymerized in these two media; at –78°C, the rate was higher in paraffin oil than in the adipate mixture. Styrene was irradiated in paraffin oil and acrylonitrile in the adipate mixture. The reaction was similar to that observed with other monomers. The rate was higher with very diluted solutions. Copolymerizations of mixtures St + MAM and AN + MMA were carried out in the same media. The kinetics of these reactions and the copolymer compositions were similar to those of the corresponding radical copolymers. The structure of these solid mixtures at low temperature was examined with x rays, with the polarizing microscope and the electron microscope. Data showed a separation into two phases. The kinetics of the observed polymerization are explained on the basis of this study. (auth)

14543 INVESTIGATION OF THE KINETICS AND MECHANISM OF RADIOCHEMICAL AND PHOTOCHEMICAL GRAFTING OF ACRYLONITRILE FROM THE GASEOUS PHASE TO POLYAMIDE FIBERS. Kachan, A. A.; Chervyatsova, L. L.; Kornyev, K. A.; Mertvichenko, E. F.; Gnyp, N. P. (Inst. of Macromolecular Chemistry, Kiev). J. Polym. Sci., Part C, No. 16, 3033-9 (1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

Grafting from the vapor phase of acrylonitrile, vinyl acetate, vinylpyridine, and isoprene to polyamide fibers was effected by radiation and photochemical initiation. The absence of a homopolymer in vapor-phase grafted polymerization made it possible to take its kinetics continuously during the reaction in adsorption vessels with the aid of MacBen scales. Dependences of the reaction rate on the radiation dose, monomer vapor pressure, duration of experiment, and temperature were obtained. The basic kinetic peculiarities of the process were studied on a model reaction of grafted polymerization of acrylonitrile on capron fiber. Grafting was shown to occur chiefly according to an "impact" mechanism. The observed negative temperature coefficient of the reaction was due chiefly to the decay of free radicals. Values were obtained on the increment rate and chain scission constants at 22, 40, and 60°C., and the corresponding activation energy values. The quantum yield of free radical formation on capron was calculated for a wavelength of 2537 A. ($G = 1.7 \times 10^{-5}$). The results of the calculation of G were compared with those obtained by measuring the ESR spectra. (auth)

14544 RADIOCHEMICAL CROSSLINKING OF POLYOLEFINS IN THE PRESENCE OF SULFUR MONOCHLORIDE. Kachan, A. A.; Chervyatsova, L. L.; Kaurkova, G. K. (Inst. of Macromolecular Chemistry, Kiev). J. Polym. Sci., Part C, No. 16, 3041-5(1967).

From IUPAC Meeting on Macromolecular Chemistry, Prague. See CONF-650801-(Pt.5).

In the presence of sulfur monochloride the gamma dose may be considerably reduced during radiochemical crosslinking of polyolefins. Thus, in the case of polyethylene practically complete crosslinking is attained with a dose of 0.1 Mrad, i.e., by three orders lower than with ordinarily used radiation doses. Sulfur monochloride was introduced from the vapor phase, which made it possible to apply S_2Cl_2 uniformly on the polymer, to control strictly the quantity of introduced substance, and to reduce its consumption sharply. Some peculiarities of the mechanism of the action of sulfur monochloride in the process of radiochemical crosslinking of polyethylene are clarified. It is shown that in polyethylene crosslinking occurs chiefly on bonds of the monosulfide type. The value of the radiochemical yield-of cross-bond formation was 1.25×10^3. (auth)

14545 GRAFT POLYMERIZATION OF VINYL COMPOUND ONTO CELLULOSE. Gotohda, Masao; Kubota, Hiroshi; Nazaki, Fumio; Shinzoomi (to Japan Atomic Energy Research Inst.). British Patent 1,099,239. Jan. 17, 1968. Filed Oct. 24, 1966.

A method is described for the radioinduced graft polymerization of vinyl compounds onto cellulose in which alumina or alumina-silica mixture is used as the catalyst that maintains a practicable reaction rate and yet minimizes formation of the homopolymer of the vinyl compounds. The cellulose is pre-irradiated and then soaked in the emulsifier system of the monomer and the catalyst. The reaction catalyst is present in the emulsifier system in the concentration of 10^{-4} to 5×10^{-3} moles/l. The cellulose component may be either polynosic rayon, natural cotton, or high-tenacity rayon, and the vinyl component may be either styrene, vinyl acetate, or n-butyl acrylate. (B.L.M.)

14546 THERMAL AND RADIATION EFFECTS ON THE SOLID STATE RACEMIZATION OF D-POTASSIUM TRISOXALATO CHROMIUM (III) COMPLEX. Chowdhury, Dhirendra Mohan. Buffalo, State Univ. of New York, 1967. 282p.

Thesis.

The solid compound, d-$K_3[Cr(C_2O_4)_3] \cdot 2H_2O$, was subjected to monochromatic x rays, γ rays, and thermal neutrons; and its specific rotation was measured in dimethyl sulfoxide solution, a solvent in which the compound racemises very slowly ($t_{\frac{1}{2}}$ = 92.5 hrs ±2.5). The compound d-$K_3[Cr(C_2O_4)_3] \cdot 2H_2O$ did not racemise at all under the influence of these radioactive radiations within the dose-rates used. The kinetics and mechanism of the thermal racemization of d-$K_3[Cr(C_2O_4)_3] \cdot 2H_2O$ in the solid state and the influence of the thermal neutron-irradiation on these rates was studied. The suitable temperature range for this kinetic study was 224 to 251°C. It was found that air, deficiency of air, and nitrogen do not have any accelerating or retarding influence on the rates of the thermal racemization of the solid hydrate, d-$K_3[Cr(C_2O_4)_3] \cdot 2H_2O$, and of solid anhydrous compound, d-$K_3[Cr(C_2O_4)_3]$. The half-lives of racemization and hence, the rates of racemization are different for different hydrate samples prepared at different times, and similarly different are the rates of racemization of the different anhydrous samples prepared from different hydrates. But the rates of racemization of the hydrate sample are almost exactly the same as the rates of racemization of the anhydrous sample, provided the anhydrous sample is always prepared from the same hydrate as is used for the kinetic runs with the hydrate samples. Water of crystallization did not play an important role in the thermal racemization of the two solid compounds. But if water vapor from the evaporation of this water of crystallization of the hydrate sample was allowed to build up its pressure on the surface of the sample during such kinetic runs, then water definitely played a great role in this racemization process, (kinetic runs with hydrate samples in the metal-block furnace). All these kinetic runs showed an induction time prior to the usual first-order decay law for racemization. The first-order rate law for racemization has been obeyed by all these kinetic runs. The induction time and the subsequent obeying of the usual first-order rate law are explained by nucleation phenomenon. The inherent defects or dislocations present in the hydrate sample during its preparation and hence, present in the anhydrous sample prepared from such a hydrate sample, are responsible for providing potential nucleus-forming sites by their slow thermal movements. The nuclei are formed slowly in these sites, grow and decay ultimately, showing the induction time, and then follows a usual first-order decay law for the racemization process. Thermal neutron-irradiation of the hydrate and anhydrous samples slowed down the rates of nucleation and thermal racemization of both the solid compounds. This is explained by the formation of very insignificant amount of radioactive decomposition products, which block the free thermal movement of the lattice defects or dislocations, and thus inhibit both the rate of formation of the nucleus and the rate of racemization. (Disser. Abstr.)

14547 PROCESS FOR INCREASING THE CRITICAL CURRENT DENSITY OF LAYERS OF SUPERCONDUCTING INTERMETALLIC COMPOUNDS WITH β-TUNGSTEN CRYSTAL STRUCTURE BY PARTICLE IRRADIATION. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,094,570. Dec. 13, 1967. Priority date Apr. 7, 1966, Germany.

A process is described for increasing the critical current density of layers of superconducting intermetallic compounds with β-tungsten crystal structure by irradiation with protons. Protons having an energy between about 100 keV and several MeV are used, and the proton current density and the irradiation time are so measured that the integrated proton flux amounts to about 10^{15} to 10^{18} protons/cm^2. The irradiation is carried out under a high vacuum, and the layers are cooled during irradiation. (B.L.M.)

14548 THEORETICAL INVESTIGATION OF A RADIATION-INDUCED MOLECULE-ION IN ALUMINUM OXIDE. Fournier, Joseph Theophile Jr. Storrs, Conn., Univ. of Connecticut, 1966. 127p.

Thesis.

A theoretical study of the electronic structure of an AlO^{3-} molecular ion stabilized in a double anion vacancy of the Al_2O_3 lattice was undertaken for the purpose of determining the suitability of this ion as a model for part of the spin resonance spectrum observed in neutron-irradiated Al_2O_3. A molecular orbital approach was employed using MO's constructed from O_2 2s and 2p and Al 3s and 3p wavefunctions. The interactions of the twelve valence electrons with each other and with the O^{6+} and Al^{3+} cores were approximated by a single-electron potential, which is a sum of two atomic potentials. The atomic potentials are constructed from selfconsistent wavefunctions for various O and Al ions. A calculation of the crystal potential was performed on a point ion model, and the crystal energy was included in the Hamiltonian defining the molecular system. Single electron energies and total molecular energy were determined for five values of internuclear separation. It was not possible to obtain a value for the equilibrium internuclear separation without configuration mixing. However, for an internuclear separation in the range 0.75 to 1.0 times the normal anion–anion separation, the molecule was found to possess a half-filled π orbital, which gives rise to a $^3\Sigma$ ground state. Thus, over a reasonable range of internuclear separation the model has a spin consistent with the observed spin value S = 1. The calculated value of the zero-field splitting, 2.0 cm^{-1} was nearly thirty times the observed value of magnitude 0.071 cm^{-1}. This large discrepancy is attributed to the lack of electron correlation in the simple molecular orbital picture. Finally, it is likely that an optical absorption with a calculated transition energy of about 2.2 eV correlates with one of the observed absorptions of positive optical anisotropy. A qualitative discussion of the sort of configuration interaction needed is presented. (Disser. Abstr.)

14549 RADIATION-INDUCED CHANGES IN THE MOLECULAR WEIGHT OF POLYSTYRENE IN THE PRE-GEL REGION. Alberino, Louis M. Evanston, Ill., Northwestern Univ., 1966. 221p.

Thesis.

An analysis of the effects of intramolecular crosslinking induced by radiation over a wide range of initial molecular weight samples gave some information on the chain conformation of amorphous polystyrene. The samples were prepared by thermal bulk polymerizations with no catalyst and by thermal solution (ethylbenzene) polymerizations with no catalyst. The initial molecular weights ranged from 56,000 to 3,370,000. The samples were cast as thin films from benzene solutions and from cyclohexane solutions. The thin films were irradiated in a vacuum in a ^{60}Co source of γ rays. Gel-points of the irradiated samples were found by determining the changes in the weight-average molecular weight by light-scattering in the pre-gel region, and these changes can be used to measure the gel-point radiation dose for a wide range of initial molecular weights. The changes in the number-average molecular weight in the pre-gel region were also determined for some samples by osmometry and are in agreement with the results of random crosslinking theory. Combination of the light-scattering and osmometry measurements can be used to determine the G-value for crosslinks and the chain scission parameter. These two techniques can detect small changes in the initial stages of irradiation that might not be noticeable by purely chemical techniques. A nonrandom crosslinking theory was developed that allows an analysis of the effects of intramolecular crosslinking on the gel-point relationship. This nonrandom crosslinking analysis was applied to the light-scattering results, and from this analysis information was obtained on the chain conformation of linear amorphous polystyrene. The molecular weight of the irradiated solution polymers was found to increase abnormally rapidly in the low dose range of the pre-gel region. This effect is explained by a coupling type reaction that occurs in addition to random crosslinking or chain scission and is completed after the sample has received the gel-point radiation dose. The results of the chain conformation analysis indicated that the casting solvent has no effect on intramolecular crosslinking and that bulk amorphous polystyrene chains are not more compact than their θ-solvent dimensions. (TSS) (Disser. Abstr.)

14550 OPTICAL AND ELECTRICAL PROPERTIES OF RARE EARTH THIN FILMS. Okorie, Ogba Agba. Washington, D. C., Howard Univ., 1967. 126p.

Thesis.

The optical and electrical properties of some rare earth thin films deposited by vacuum evaporation were investigated. Qualitative studies were carried out on the effect of aging and x irradiation on the transmission of the thin films. Ytterbium, neodymium and samarium thin films were studied. The quantitative study was based on the Yb film data, and only qualitative study was made on Sm and Nd films. The work covered the spectral region 0.8 to 6.8 microns in the infrared. From the transmission and reflection data, the refractive index n, the extinction coefficient k, and the absorption coefficient were obtained. The resistivity measurements yielded information concerning the types of carriers and their densities. The resistivity and absorption coefficient data confirmed Bridgman's prediction that ytterbium can become a degenerate semiconductor due to pressure effects. Drude theories applied well to the spectral ranges 1 to 3.5 microns. Hagen–Ruben's formula also applied at intervals. Plasma oscillations were also established to occur in the films. From the absorption coefficient the indirect transition absorption edge was determined to be 1.8 eV. By assuming a spherical fermi surface, the carrier velocity was calculated. Based on the study of the relaxation time of the carriers it could be concluded that some of the carriers are

predominant in one region and the others in another. From the consideration of the relaxation time of the carriers it was necessary to investigate the anomalous skin effect of the films. The penetration depth varied from 150 to 417A, the mean free path of the carriers was determined to be 236A, and the carrier velocity is 3.17×10^7 cm/sec. while the relaxation time is 7.45×10^{-14} sec. (Disser. Abstr.)

14551 EFFECT OF CHAIN GROWTH RETARDATION IN THE GRAFT POLYMERIZATION OF STYRENE ONTO CELLULOSE ACETATE. Hamburger, Charles Joseph. Appleton, Wis., Lawrence Univ., 1967. 71p.

Thesis.

The effect of nitrobenzene, a known retarding agent, on the graft polymerization of styrene onto pyridine-swollen cellulose acetate film was studied. Polystyrene-cellulose acetate graft polymers were prepared by direct irradiation from ^{60}Co γ rays for 20 MRADs at 0.44 MRAD/hr. After isolation of the graft polymers by selective extraction, the chemical composition, osmometric side chain D.P., and some intrinsic viscosities were measured. Based on the amounts of grafted polystyrene and grafted cellulose acetate, graft polymerization was limited by diffusion-controlled growth in the absence of nitrobenzene when the substrate was not highly swollen. Under these conditions, nitrobenzene additions increased the amount of grafted polystyrene and grafted cellulose acetate. However, when the substrate was highly swollen, polymer growth within the substrate was reaction-controlled in the absence of nitrobenzene. Nitrobenzene additions reduced the amount of grafted polystyrene under highly swollen conditions. Additional nitrobenzene decreased the amount of grafted polystyrene under all reaction conditions. Appreciable insoluble residues in the polystyrene formed without nitrobenzene indicated that these polymers contained cross-linked gels. The amount of gel increased with increasing D.P. of the associated soluble polystyrene. The crosslinking originates from coupling reactions between branched units on the grafted polystyrene chain. Viscometric evidence indicated that the polystyrene was branched. Nitrobenzene prevented the formation of crosslinked gels in all cases. This compound adds to chain radicals, forming an adduct too unreactive for further monomer addition. Termination between this adduct and the radical chain end proceeds by disproportionation, and not by coupling. Therefore, crosslinking in the presence of nitrobenzene is highly improbable. The number of polystyrene side chains per cellulose acetate chain was determined, and the values suggested that between two to four cellulose chains were connected to one polystyrene chain. The samples may contain occluded ungrafted cellulose acetate that was not removed in the purification. (Disser. Abstr.)

14552 LOW ENERGY ELECTRON IRRADIATION OF THIN FILMS OF ETHENE AND ETHANE AT 63°K. Gill, Piara Singh. Manhattan, Kan., Kansas State Univ., 1967. 90p.

Thesis.

The low-energy electron bombardment of ethene and ethane at 63°K was studied. Electrons produced by thermionic emission from an oxide-coated platinum cathode were directed to bombard a thin film of either ethene or ethane at 63°K. The energy of the electron beam was varied from 8.7 to 48.7 eV. The products of the reactions were analyzed by gas chromatography using a chromatograph fitted with dual hydrogen flame ionization detectors. Some reactions were also run using tritiated ethene and ethane as the reactants. The major products from electron bombardment of ethene at 63°K were acetylene, hydrogen, ethane, n-butane, 1-butene, and 2-butene. It is proposed that ethene molecules were excited by the bombarding electrons. Hydrogen atoms thus produced further added to ethene molecules to give ethyl radicals. To determine the role of free radicals in the formation of products, electron bombardment of ethene was carried out in the presence of nitric oxide, which acted as a free-radical scavenger. In the presence of nitric oxide, most of n-butane and ethane and 55% 1-butene were eliminated. The scavengable fractions of these products were formed via a free-radical mechanism. The rest of 1-butene and practically all the 2-butene are suggested to come from molecular processes. The major products from electron bombardment of ethane at 63°K were hydrogen, ethene, acetylene, propane, and n-butane. In addition to these products and small amounts of cyclopropane and propene some 1-butene was also present. The first step towards the formation of these products is proposed to be the excitation of ethane molecules by the low energy electrons. The free radicals and hydrogen atoms underwent further reactions to form the products. The role of free radicals was determined in the reactions by using nitric oxide as a free-radical scavenger. By the addition of nitric oxide to the ethane film 72% of the methane, 76% of the propane, 64% of the ethene, and more than 90% of the n-butane were scavenged. The acetylene yield was practically unaffected by the addition of nitric oxide. A molecular process in which hydrogen is eliminated from an excited ethane molecule is proposed to give rise to acetylene. When ethene or ethane was bombarded with electrons of energy above or below its ionization potential, the product distribution did not change. Propane and methane were among the major products in high energy radiolysis of ethene in the gas phase. Their precursors were proposed to come from ion-molecule reactions. It is suggested that the main primary process was the direct excitation of ethene and also of ethane by electrons. (Disser. Abstr.) (TSS)

14553 FREE RADICAL REACTIONS IN IRRADIATED CYCLOHEXANECARBOXYLIC ACID. Leung, Paul Man-Kit. Toronto, Univ. of Toronto, 1967.

Thesis.

Because of the symmetry of the molecule, which limits the number of intermediate and final products, cyclohexane has often been used to study the mechanisms by which ionizing radiation produces changes in organic molecules. In the experiments reported here, the effects of substituting a carboxyl group onto cyclohexane were studied by observing the formation and decay of free radicals in cyclohexanecarboxylic acid (CCA) using electron spin resonance (ESR) techniques. The free radical mechanisms suggested by these observations were confirmed by a partial analysis of the radiolysis products. When CCA was irradiated at –120°C, the observed ESR spectrum showed that there was a mixture of at least three free radical species present. These free radicals were the cyclohexyl radical ($c-C_6H_{11}\cdot$), the cyclohexylcarboxylic acid radical ($\underline{C_5H_{10}C}-COOH$, abbreviated as CCA radical), and an unknown radical that gave a singlet ESR spectral line and was probably the $c-C_6H_{11}CO\cdot$ radical. The relative yields of these radicals were 5 ($c-C_6H_{11}\cdot$): 2 (CCA radical): 3 (unknown radical). When the temperature of the irradiated sample was raised above –120°C, there were significant changes in the structure of the ESR spectrum, some being irreversible and some reversible. At –30°C, the ESR spectrum was that of the CCA radical alone. The irreversible changes were due to the decay of the ESR signals from the cyclohexyl and the unknown radicals, and to a two fold increase in the CCA radicals. The reversible changes in the CCA radical were interpreted in terms of chair-chair-interconversion of the cyclohexyl ring. The rate and activation energy for the inversion were calculated to be 6.2×10^8 (0°C), and 3.4 k cal/mole, respectively. The radiolysis products, cyclohexane, CO, CO_2, H_2, H_2O, and bicyclohexyl, which were separated and identified by gaschromatographic methods, were consistent with the above observations. However, it was not possible to identify all the radiolysis products produced so that a complete mechanism cannot be postulated. The increased concentration of the stable CCA radicals observed after the irradiated sample was heat annealed suggests that the cyclohexyl radicals formed initially by radiation react with the parent CCA molecules. This proposed reaction was further confirmed by the ESR studies and the measurements of the radiolysis products in cyclohexane–CCA mixtures. (Disser. Abstr.)

14554 IMPROVEMENTS IN AND RELATING TO PROCESS FOR THE MANUFACTURE OF GRAFT COPOLYMERS. (to Farbwerke Hoechst Aktiengesellschaft). British Patent 1,099,991. Jan. 17, 1968. Priority date Feb. 8, 1964, Germany.

A process is described for the manufacture of a graft copolymer in which a monomer that contains a vinyl or vinylidene group is graft-polymerized onto a trunk polymer or copolymer comprising units of a monomer containing at least one halogen atom that is activated by an ester or a phenyl group. The polymerization is carried out in the presence of a catalytic amount of a free-radical polymerization catalyst and under the action of uv light or high energy ionizing radiation. (B.L.M.)

14555 GAMMA RADIOLYSIS OF DILUTE AQUEOUS SOLUTIONS OF CINNOLINE. Sabin, John Rogers. Durham, N. H., Univ. of New Hampshire, 1966. 138p.

Thesis.

The γ-radiation chemistry of deaerated, dilute aqueous solutions of cinnoline was studied using a 62 Ci ^{60}Co source. The products of the radiolysis were identified, and yields for each of the products were calculated. The major products identified were G(-cinnoline), H_2, NH_3, H_2O_2, and organic products. In both aerated and deaerated solutions destruction of cinnoline was linear with dose, and no effect of initial concentration on the G-values was found. The effect of added H_2O_2 caused a deviation from linearity for short irradiation times, but the curve was found to be linear at longer irradiation times with no effect on the G-value. Added Br^- had the expected result of lowering G(-cinnoline). The yield of H_2 equaled the primary yield for deaerated solutions. Higher yields were obtained for the aerated solutions. Ammonia was the principal nitrogen-containing product of the radiolysis, and its yield was measured in deaerated solutions. This yield was constant with increasing dose up to 20% decomposition of cinnoline. Yields of H_2O_2 were measured in both aerated and deaerated solu-

tion and were higher than primary in both systems. In neither system was a linear plot of production of H_2O_2 vs. dose obtained. The major product of the radiolysis (~60%) was a dimer of the cyclohexylethyl radical. Yield of this product was measured in both aerated and deaerated systems, and yields were much lower in aerated systems, which indicate a change of mechanism in the process on adding O_2 to the system. A minor product was identified as 1,4-dihydrocinnoline, and its yield was measured in the deaerated system. Using the experimental data, a material balance was obtained, which was internally consistent and consistent with known values for primary yields of active species. A partial mechanism for the radiolysis of cinnoline in deaerated solutions was then postulated and shown to be consistent with the experimental evidence. (Disser. Abstr.)

14556 ELECTRON PARAMAGNETIC RESONANCE STUDY OF RADIOLYSIS PRODUCTS OF CERTAIN TRIPHENYLMETHYL DERIVATIVES AND GROUP IV ORGANOMETALLICS. Ayers, Caroline Grist LeRoy. Athens, Ga., Univ. of Georgia, 1966. 128p.

Thesis.

Radiolysis of triphenylmethyl chloride, triphenylmethyl bromide, and triphenylacetic acid produces triphenylmethyl radicals. The radicals formed in the crystal lattice react with O_2 to give triphenylmethylperoxy radicals. The reaction of triphenylmethyl with O_2 is reversible. Since the equilibrium constant is independent of small changes in O_2 pressure at atmospheric O_2 pressure, an apparent equilibrium constant can be measured as a function of temperature. The ΔH^0 for the reaction is 9.0 kcal mole^{-1}. Assuming the activity of O_2 in the solid to be 0.2 atm, ΔG^0 is 2.2 kcal mole^{-1} and ΔS^0 is 23 gibbs mole^{-1} at 25°C. Assuming constant excess of O_2, the rate constants for the decomposition of triphenylmethylperoxy to triphenylmethyl and O_2 at reduced pressure were determined to be 2.83×10^{-2} min^{-1} at 25°C, 7.66×10^{-2} min^{-1} at 40°C, 9.74×10^{-2} min^{-1} at 50°C, and 1.79×10^{-1} at 60°C. The activation energy for the process is 10.2 kcal mole^{-1}. Radiolysis of 9-phenylfluorene-9-carboxylic acid resulted in the 9-phenylfluorenyl radical. The radical reacts with O_2 to form the 9-phenylfluorenylperoxy radical. Since the equilibrium with O_2 is much more slowly attained than in the triphenylmethyl system, the equilibrium constant could not be measured as a function of temperature. Radiolysis of triphenylmethyl peroxide and triphenylmethyl hydroperoxide produces diphenylphenoxymethyl radical. No peroxy radical was formed upon admission of air to the sample. Radiolysis of diphenylacetic acid, 2,2-diphenylpropionic acid, and 2,2-diphenylbutyric acid resulted in the loss of the carboxyl group. Only diphenylmethyl radical formed the peroxy radical upon admission of air. The reaction does not appear to be reversible. The pentaphenylcyclopentadienyl radical formed upon radiolysis of pentaphenylcyclopentadienyl chloride did not form peroxy radicals upon admission of air to the sample. Radiolysis of the polycrystalline organometallic tin halides and organometallic lead halides and acetates was found to result in the formation of radicals which were reasonably stable at room temperature. In most cases, radicals were stable for 2 or 3 days at room temperature. It was observed that the radicals produced upon radiolysis of halides corresponded to loss of a halogen atom. Radiolysis of the lead acetates resulted in cleavage of a lead–acetate bond (except, perhaps, for phenyllead triacetate). The small radical yield in irradiated tetraphenyllead is a further indication of the relative stability of the lead–phenyl bond toward radiation. Radiolysis of hexaphenyldilead and hexaphenylditin probably results in an ionized molecule which is reasonably stable at room temperature. Metal–metal and metal–phenyl bond cleavage are also possibilities. Since no radicals are detected in irradiated hexaphenyldisilane and only a low concentration in triphenylsilyl chloride, it is concluded that the corresponding silyl radicals are unstable even in polycrystalline samples at room temperature. (Disser. Abstr.)

Radiochemistry

Refer to abstracts 14426, 14513, 14530, and 14681.

Separation Processes

Refer also to abstracts 14454, 14512, 14517, 14525, 15140, 16110, and 16356.

14557 (BMI-X-490) STUDIES OF OFF-GAS FILTER PLUGGING IN THE PRIMARY REACTOR OF THE FLUIDIZED-BED FLUORIDE VOLATILITY PROCESS. Miller, Paul D.; Stephan, Elmer F.; Boyd, Walter K. (Battelle Memorial Inst., Columbus, Ohio). Feb. 19, 1968. Contract W-7405-eng-92. 17p. Dep. CFSTI.

In tests of materials for the FBFVPP (Fluidized-Bed Fluoride Volatility Process Plant), plugging of nickel Feltmetal off-gas filters was found, primarily during simulated decladding. To determine the cause of plugging, a 0.5-in.-ID reactor was constructed with downstream nickel Feltmetal filters, and used to investigate filter plugging resulting from single or combined decladding variables: namely, HCl, alumina heat exchange bed, and the products of the HCl–Zircaloy-2 reaction. HCl–nitrogen caused severe plugging at 350, 400, and 450°C. Plugging decreased with decreasing temperature. Plugging was caused by the formation of $NiCl_2$ in the body of the filter. HCl corroded nickel at an overall rate of 0.5 mil per month under decladding conditions. Zircaloy-2 dissolution by HCl–nitrogen at 400 and 365°C in a fluidized bed of alumina also resulted in severe plugging. Apparently, deposition of nonvolatile fines (largely ZrO_2) on the filter surface caused the loss of porosity. Slight plugging resulted from the sweeping of alumina fines to the filter surface. Possible means of reducing plugging are suggested and possible alternative filtration is discussed. (auth)

14558 (CEA-R-3366) EPURATION DE L'HELIUM DE COUVERTURE DES REACTEURS NUCLEAIRES PAR ADSORPTION SUR TAMIS MOLECULAIRE. (Purification of the Helium Blanket of Nuclear Reactors by Absorption Through a Molecular Sieve). Rozenberg, Jean; Kahan, Henryck (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 22p. (In French). Dep.

A method carried out at fairly low temperatures (between −50 and −80°C) has been studied for the purification of helium used as cover gas for heavy water in reactors. The use of the 5A molecular sieve has been adopted because of its superiority over other adsorbants in this temperature range. The particular problems connected with adsorption under dynamic conditions have been dealt with separately. The nitrogen adsorption isotherms have been plotted and the heat of adsorption calculated. (auth)

14559 (KFK-671) VERTEILUNGSDATEN FUER PU(IV) UND U(VI) UND DEREN RECHNERISCHE ERMITTLUNG IM SYSTEM METALLNITRAT-SALPETERSAEURE UND TRIBUTYLPHOSPHAT. (Distribution Characteristics of Pu(IV) AND U(VI) and Their Mathematical Determination in Metal Nitrate–Nitric Acid and Tributyl Phosphate Systems). Ochsenfeld, W.; Schmieder, H.; Baumgaertel, G.; Kuhn, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Sept. 1967. 22p. (In German). (EUR-3703). Dep.

From a great number of experimentally determined distribution data and from literature values, a theoretical equation was established for calculation of the distribution coefficients of U(VI) and Pu(IV) between HNO_3 and TBP-dodecane systems. The calculated and experimental values agreed over wide concentration ranges. The calculations were carried out with the IBM 7074. (tr-auth)

14560 (NUMEC-1661-1) RECOVERY OF PLUTONIUM FROM ZPPR UNMEASURABLE WASTES. Progress Report, July 27, 1967–January 27, 1968. Bragg, R. L.; Fisher, F. D. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT-(11-1)-1661. 42p. Dep. CFSTI.

The recovery of Pu from unmeasurable waste by total incineration and total laundering is reported. Unmeasurable wastes are defined as plutonium-bearing heterogeneous solid wastes that are generated during the fabrication of ZPPR ternary alloy fuel plates. Typically, these wastes are PVC bags, neoprene gloves, paper wipes, carboard boxes, molds, crucibles, brushes, and tools. The general mechanical and operating characteristics of three government-owned facilities that process plutonium-contaminated wastes by incineration are outlined. The advantages and disadvantages of those facilities relative to the processing of ZPPR unmeasurable wastes were evaluated and are tabulated. Plastic and neoprene gloves were largely laundered (leached) instead of burned. Tests demonstrated 87% recovery of Pu using a 7.2M nitric acid wash and also 87% recovery using a clear water wash. (P.C.H.)

14561 (ORNL-4139) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, JANUARY–MARCH 1967. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 74p. Dep. CFSTI.

Progress is reported in 5 sections, and a separate abstract was prepared for each section. (M.C.G.)

For abstracts of individual sections see: 14481 and 14562–14565.

14562 (ORNL-4139, pp 4-18) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

The 18-stage prototype stacked-clone contactor, designed for use with highly radiochemical solutions, was tested with systems

and flowsheets that simulate those to be used in the solvent extraction process for recovering ^{233}U. Uranium processing rates were 30 to 35 kg/day for an aluminum nitrate-containing feed and as high as 55 kg/day for an acid feed. Stripping proceeded at rates as high as 44 kg/day. Operation of the prototype contactor with the organic phase continuous in the countercurrent zone was demonstrated. This mode of operation requires no external settler and consequently reduces the solvent inventory. The control of an internal interface was shown to be feasible. (auth)

14563 (ORNL-4139, pp 19-22) ENGINEERING SEPARATION OF MACROMOLECULAR BIOLOGICAL SUBSTANCES. (Oak Ridge National Lab., Tenn.).

The inventory of mixed tRNA (about 370 g) was processed to yield a product (1.5 g) containing 66% phenylalanine tRNA, 2.5% leucine tRNA, 11% tryptophan tRNA, and 20% of an unknown contaminant that is not an active tRNA. Techniques, developed too late to be used during this report period, show promise of greatly simplifying future work. (auth)

14564 (ORNL-4139, pp 23-42) POWER REACTOR FUEL PROCESSING. (Oak Ridge National Lab., Tenn.).

The 250-ton prototype shear is undergoing extensive modifications in preparation for shearing a 10- by 10-in. porcelain-filled prototype fuel assembly. The temperatures attained by a large fuel assembly during shear-leach processing were calculated at an assumed burnup of 100,000 Mwd per metric ton of uranium, specific powers of 75, 100, 125, and 150 kw per kilogram of uranium, and decay times of 30 to 240 days (in 30-day increments). The maximum temperatures varied from 231°F in the receiving canal to 3095°F at the center line of a 7¾-in.-ID storage basket filled with sheared fuel. The crushing of large blocks of graphite fuel by means of a falling weight (prior to a further size reduction by hammer milling or roll crushing) was tested and found to be infeasible. (auth)

14565 (ORNL-4139, pp 48-72) MOLTEN-SALT REACTOR PROCESSING. (Oak Ridge National Lab., Tenn.).

Studies were made of the calculated effect of a concentration gradient in a semicontinuous still, of factors limiting the vaporization rate in the still, and of the error in measured relative volatilities. For typical operating conditions, the error in measured relative volatilities is approximately 1%. (auth)

14566 (ORO-2124-12) PROPERTIES AND STRUCTURES OF SOLVATES OF METAL CHELATES ENCOUNTERED IN SOLVENT EXTRACTION SYSTEMS. Progress Report, January 1–December 31, 1967. Wagner, William F.; Sands, Donald E. (Kentucky Univ., Lexington. Dept. of Chemistry). Jan. 16, 1968. Contract AT(40-1)-2124. 11p. Dep. CFSTI.

Structures of monohydrates of rare earth trisacetylacetonates are being studied. Some data are given for the Y, Pr, Yb, and La compounds. A structural investigation is also in progress on the hexafluoroacetylacetonate chelate salt $NH_4(C_5F_6HO_2)_4 \cdot H_2O$. Stability constants of rare earth acetylacetonates are being calculated from solvent extraction data. The attempted synthesis of rare earth chelates of 4-amino-3-penten-2-one failed. (M.C.G.)

14567 ANION-EXCHANGE SEPARATION OF THORIUM FROM THE RARE EARTHS IN AN ACETONE-HYDROCHLORIC ACID MEDIUM. Cummings, T. F.; Korkisch, J. (Univ., Vienna). Anal. Chim. Acta, 40: 520-3(Mar. 1968).

The adsorption of thorium and the rare earths by strongly basic anion exchange resins was measured in systems with high hydrochloric acid concentration that also contained appreciable percentages of acetone. A method was developed for the anion exchange separation of these elements with a hydrochloric acid medium as eluent. It was found that the maximum separation factor for thorium and the rare earths occurred at the concentration of 75% acetone–25% hydrochloric acid. Distribution coefficients for various metals at this concentration are tabulated. Lanthanum, cerium, and holmium could not be separated from each other since all have approximately the same value. Iron, nickel, calcium, and magnesium did not interfere with the separation of lanthanum and thorium. When tetrahydrofuran, methanol, ethanol, 1-propanol, and 2-propanol were used instead of acetone, the distribution coefficients of thorium and lanthanum were too similar to permit good separation. (D.H.M.)

14568 KINETICS OF THE FLUORINATION OF URANIUM DIOXIDE PELLETS BY FLUORINE. Iwasaki, M. (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Mater., 25: 216-26(1968).

The fluorination of uranium dioxide pellets to UF_6 with fluorine has been studied in the temperature range of 300 to 540°C, using a thermobalance. Below 430°C, a thick layer of intermediate scale was formed on the unreacted pellet core. In this range, by surveying the relationship between the rate of the reaction and the fluorine partial pressure, it was concluded that chemisorption of fluorine takes place. Above 430°C, on the contrary, the quantity of the intermediate was generally small. Although the formation of UO_2F_2 was confirmed as the only definite compound in the intermediate by x-ray analysis, the atomic ratio of fluorine to uranium in the intermediate was usually less than that of stoichiometric UO_2F_2. From this result, the following consecutive reaction steps were considered: UO_2 pellet → UO_2 powder (partly fluorinated) → UO_2F_2 powder → UF_6. The occurrence of the above two types of reaction was explained by the relations between the magnitude of rates of these steps. The mechanism of each step is also discussed. (auth)

14569 POSSIBILITY OF THE DETERMINATION OF A COMPOSITION OF EXTRACTABLE COMPLEXES OF METALS WITH AMINES OF HIGH MOLECULAR WEIGHT BY PAPER CHROMATOGRAPHY. Przeszlakowski, S. (Faculty of Pharmacy, Lublin). Rocz. Chem., 41: 1681-8(1967). (In Polish).

The effect of the Amberlite LA2 hydrochloride concentration in the impregnating solution on R_M values of zinc, iron(III), cadmium, indium(III), uranium(VI), tellurium(IV), and rhenium(VII) was determined at constant concentration of hydrochloric acid in the developing aqueous solution. It was possible to determine the composition of extractable complexes of metal chlorides and salts of high molecular weight amines from the graphical relationship between the R_M values and the logarithm of concentration of the amine salt. The results obtained for zinc, rhenium, and tellurium indicate a 1:1 metal salt to amine salt mole ratio, while for indium, iron, uranium, and cadmium this ratio was found to be 1:2. The results obtained for uranium, iron, and indium are in agreement with the composition of their extractable chloride complexes with amines reported in the literature, determined by extraction in analogous conditions. The effects of the halide ion concentrations on R_M values of rhenium(VII) (which is probably extracted in the form of ReO_4^-) were also investigated. It was found that the R_M values of rhenium decrease in the order $F^- > Cl^- > Br^- > I^-$ which is consistent with the observation that the affinity of halide ions to solid ion exchangers as well as the affinity of hydrohalide acids to high molecular weight amines decrease in the opposite direction. (auth)

14570 SOLUTION OF CAUSTIC SODA AS A CATALYST FOR ISOTOPIC EXCHANGE BETWEEN HYDROGEN AND WATER IN TRANSFER COLUMNS FOR TECHNICAL ENRICHMENT OF DEUTERIUM. Schindewolf, U.; Hornke, J. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech., 40: 29-30(Jan. 19, 1968). (In German).

Aqueous sodium hydroxide was studied as a catalyst for isotope exchange between hydrogen and water in a transfer column for the technical enrichment of deuterium. The high plate efficiency that can be achieved permits the transfer of deuterium from water to hydrogen in a small column; the hydrogen is then subjected to a deuterium enrichment process. The combination of the enrichment plant with the transfer column makes unlimited heavy-water production capacities feasible. (auth)

14571 AUTOMATIC CHROMATOGRAPH FOR ELUTION CHROMATOGRAPHY OF TRACE AMOUNTS OF RADIOACTIVE MATERIALS. Alexa, J. (Inst. of Nuclear Research, Rez, Czechoslovakia). Isotopenpraxis, 3: 288-9(July 1967). (In German).

An automatic chromatograph is described and a schematic diagram given. (M.C.G.)

14572 RING-OVEN TECHNIQUE AS APPLIED TO RADIOCHEMICAL PROBLEMS. Weisz, H.; Klockow, D. (Univ., Freiburg i. B.). Isotopenpraxis, 3: 265-8(July 1967). (In German).

A short introduction into the ring-oven technique is given, and the application of this microchemical method to radiochemical separations is explained with some examples: fast "mother-daughter" separations ($^{137}Cs/^{137m}Ba$, $^{99}Mo/^{99m}Tc$) on circular filters impregnated with inorganic ion exchangers and a separation scheme for uranium fission products with medium to long half-lives. (auth)

14573 SEPARATION OF CARRIER-FREE ^{125m}Te AND PURIFICATION OF TIN FROM MICROQUANTITIES OF ANTIMONY, TELLURIUM, AND INDIUM BY MEANS OF VACUUM EVAPORATION METHOD. Karasev, B. V.; Sychev, Yu. N. Radiokhimiya, 9: 519-21(1967). (In Russian).

Data are presented to show that carrier-free ^{125m}Te may be separated from neutron-irradiated tin by vaporization from the liquid medium. Similarly, the tin may be purified by vaporization of the microquantities of ^{125m}Te, ^{125}Sb, and ^{113}In produced in the irradiation. From a drop of liquid tin, tellurium comes off at 450

to 500°C, the indium at 700 to 750°C, and the antimony at 900 to 950°C, and the vapors are condensed on collectors at different temperatures. The vapor pressure of tin at 1000°C is negligible. About 15 to 20 min was required to separate half of the isotopes from a 30-mg droplet, and 1.5 to 2 hr to remove the impurities to the limits of sepectrometric detectability. Radiographic studies were made on thin slices of tin droplets to show the distribution of the radioisotopes in the droplet and thus the effect of surface on the vaporization. (TTT)

14574 DECONTAMINATION OF ^{239}Pu FROM Pt PLATES. Iwaya, Shinkichi; Wadachi, Yoshiki (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 2: 134-7(Sept. 1967). (In Japanese).

The possibility of reusing plates soiled by ^{239}Pu in counting sample preparation was investigated by decontamination experiments of washing and immersion. Results showed that water washing had no effect, but washing with dilute HCl and HNO_3 had fair effects for removal of ^{239}Pu from Pt plates due to an ion exchange reaction. It was also found that ^{239}Pu decontaminabilities of these acids were increased with increasing acidities. The best decontamination process for ^{239}Pu was concluded to be a long period (more than one day) immersion in concentrated HCl without corrosion of Pt plates. (NSA of Japan)

14575 INFLUENCE OF METAL HYDROXIDE PROPERTIES ON INDIUM PRECIPITATION FROM ALKALI SOLUTIONS. Plotnikov, V. I.; Gibova, E. G. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 61-5(Mar.-Apr. 1967). (In Russian).

Indium hydroxide is an amphoteric substance that dissolves in excess caustic with the formation of an indate. With 0.1 mg of indium in a volume of 25 ml in the presence of ^{114}In tracer, hydroxides of Fe, Zr, Y, Th, and Cd were formed by adding 15N KOH to a nitric acid solution of the salt. The time of contact of the precipitate with the solution was 30 minutes. The amount of indium carried down increased in the following order: Fe < Zr < Y < Th < Cd. At a KOH concentration of 400 g/l, $Fe(OH)_3$ carried only 25% of the ^{114}In, while $Cd(OH)_2$ carried 80% of the ^{114}In. The other metals (Y, Th, and Zr) occupied an intermediate position. (TTT)

14576 THE SEPARATION OF $^{228}Ra/^{228}Ac$ AND $^{212}Pb/^{212}Bi$ WITH THE HELP OF EXTRACTION CHROMATOGRAPHY IN THE SYSTEM Di(ETHYLHEXYL) PHOSPHATE–HYDROCHLORIC ACID. Stronski, I.; Kemmer, J.; Kaubisch, N. (Technische Hochschule, Garching, Ger.). Z. Naturforsch., 23B: 135-7 (Feb. 1968). (In German).

Extraction and back-extraction conditions were investigated for chlorides of ^{228}Ra, ^{228}Ac, ^{212}Pb, and ^{212}Bi in column-distribution chromatography with reversed phases. Bis(ethylhexyl) phosphate was used as the extraction agent, which was adsorbed on powdered polytrifluoromonochloroethylene. Hydrochloric acid at different concentrations served as eluent. The γ spectra of ^{226}Ra and ^{228}Ra were plotted with the help of a Ge(Li) semiconductor detector. (tr-auth)

14577 IRRADIATED NUCLEAR FUEL RECOVERY. Alter, Henry Ward; Anderson, Cleve R. (to General Electric Co.). U. S. Patent 3,359,078. Feb. 10, 1965.

A method for treating an aqueous solution of irradiated nuclear reactor fuel comprises subjecting the solution to a single-cycle extraction with an organic solvent consisting of an organic amine salt selected from the class consisting of tertiary amines and quaternary ammonium salts dissolved in an inert organic diluent to produce an organic extract stream containing substantially all the Pu^{4+} and an aqueous raffinate containing substantially all of the U and fission products. Following the extraction, the organic extract is stripped with an aqueous stripping agent to reduce the Pu^{4+} to Pu^{3+} and remove substantially all the Pu and a trace of fission products as an aqueous extract. The aqueous raffinate stream is dehydrated to form substantially Pu-free anhydrous solids, which are fluorinated by reaction with F_2 to form the corresponding fluorides. In the absence of Pu fluorides, U fluoride is separated from fission product fluorides. (Offic. Gaz.) (TSS)

14578 SOLVENT CARRIER METHOD FOR THE SEPARATION OF ^{13}C AND ^{18}O ISOTOPES BY CHEMICAL EXCHANGE OF CARBON DIOXIDE WITH AMINE CARBAMATES IN NON-AQUEOUS SOLUTIONS. Agrawal, Jitendra Prasad. New York, Columbia Univ., 1967. 160p.
Thesis.

The principle of chemical exchange was applied to the separation of ^{18}O and ^{13}C. By means of a capillary-contacting flow apparatus it was demonstrated that the rate of exchange of ^{18}O between CO_2 and its reaction products with organic amines was faster by at least a factor of ten in nonaqueous solutions than in aqueous solutions. Eight butylamines, n-propyl, n-hexyl, monopropanol, monoethanol amines, morpholine, and piperidine were used in methanol solutions in an exchange column to study the overall separation S_{18} for ^{18}O and S_{13} for ^{13}C. S_{18} was found to vary from 1.40 for tri-n-butylamine to 2.40 for monoethanolamine and S_{13} was found to vary from 1.50 for tertiary butylamine to 1.96 for isobutylamine. In methanol solutions the three most effective amines were: isobutyl > monoethanol ≥ n-butylamine and the optimum operating conditions were molarity, 1.2 to 1.5M; flow rate, ~0.8 ml/cm^2-min. In 1M solutions hemin and cupric chloride catalyzed the enrichment of ^{18}O and ^{13}C, and water was found to be a strong inhibitor to the enrichment of ^{18}O although it did not interfere with the enrichment of ^{13}C. Isotope separation by exchange between CO_2 and its carbamates with n-butylamine in methanol was investigated in detail. Studies above and below room temperature for both n-butyl and isobutyl amines indicated that the room temperature was the optimum temperature for the overall separations. It was found that both ^{18}O and ^{13}C can be enriched in a single system. (Disser. Abstr.) (TSS)

14579 PROCESS OF SEPARATION OF URANIUM AND THORIUM STARTING FROM A SOLUTION CONTAINING THOSE TWO ELEMENTS. Huet, Henri; Lorrain, Christian; Mahut, Rene; Mariette, Rene; Vertes, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,360,346. Feb. 12, 1965. Priority date Feb. 14, 1964, France.

A method for the separation of U and Th from an aqueous feed of their nitrates by extraction of the feed by a solution of tributyl phosphate in an organic medium is described. Selective extraction of the U was obtained by controlling the respective volumes of the organic solution and the aqueous feed in such a manner that the concentration of U in the organic solution was close to theoretical saturation. The organic solutions were scrubbed with an aqueous solution of nitric acid and uranyl nitrate and the U recovered from the organic phase. (Offic. Gaz.) (TSS)

14580 IMPROVEMENTS IN OR RELATING TO ISOTOPIC EXCHANGE PROCESSES. Walker, Peter Thomas; Poole, Keith Roderick (to United Kingdom Atomic Energy Authority). British Patent 1,100,991. Jan. 31, 1968. Filed Jan. 7, 1966.

Developments in the dual-temperature ammonia–hydrogen process for production of deuterium-enriched materials are reported. The depleted stream of ammonia from the hot tower is split into two substreams. The first of these two substreams has its deuterium content replenished by being passed in countercurrent flow in a cold transfer tower with a free hydrogen-containing gas. The second of these substreams is passed in countercurrent flow in a cold reflux tower with the stream of pure hydrogen leaving the main cold tower and the two substreams being combined and passed to the main cold tower. Ammonia synthesis gas (hydrogen–nitrogen mixtures in a 3 : 1 molecular ratio) is used as the hydrogen-containing gas. (M.C.G.)

14581 THE REMOVAL OF RADIONUCLIDES FROM AQUEOUS SOLUTION BY HYDROUS MANGANESE AND CO-FORMED MANGANESE-IRON OXIDES. Shuckrow, Alan J. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 358p.
Thesis.

Hydrous manganese oxides and binary hydrous iron-manganese oxides were studied with regard to their colloidal and adsorptive properties. Removal of the radionuclides $^{22}Na^+$, $^{42}K^+$, $^{137}Cs^+$, $^{54}Mn^{+2}$ and $^{35}SO_4^{-2}$ from aqueous solution was examined under a number of solution conditions. Electrophoresis measurements were obtained for the several hydrous oxide systems. The reactions were designed to yield a nominal concentration of 100 mg/l of oxide. Hydrous manganese oxides were produced from the reaction between manganous ion and permanganate ion and by the oxygenation of manganous ion by air in alkaline solution. Binary iron–manganese oxides with an Fe/Mn ratio of 3/1 were obtained using reactions similar to those employed in the production of the manganese oxides. One method of production of the mixed oxide involved an oxidation–reduction reaction between ferrous ion and permanganate ion in basic solution. The second binary oxide was obtained by the slow manual addition of a mixed Fe^{+3}–Mn^{+2} reagent to an aqueous solution which was maintained at a constant pH of 10.6 and agitated vigorously to insure an adequate air supply. The constant pH was obtained by means of an automatic titration apparatus which added 0.10N base as required during the formation of the oxide. The pH of the various suspensions was adjusted over a wide range of values (pH 3 to 12) after formation of the oxides. Electrophoretic mobility of the hydrous oxide particles was measured in a Briggs cell following pH adjustment and was subsequently correlated with the removal of radioactive ions from solution. Three alkali metal ion bases, LiOH, NaOH, and KOH, were employed in the formation and pH adjustment of the several hydrous oxide systems and the effects of these cations on the electrophoretic mobility and adsorptive

properties were examined. In all of the cases studied, the electrophoretic mobility remained negative in the pH range 3 to 12. Radioactive ion removal studies were carried out under the same conditions as the electrophoretic mobility studies. In most cases, the tracer was added to the system prior to formation of the particular hydrous oxide. However, in some instances, a post formation spike technique was employed and was found to yield the same results as the prespike technique. The removal of ^{137}Cs, when present in tracer quantities, ranged from 35% by one of the hydrous manganese oxides to less than 1% for one of the binary oxides. Similar results were obtained for $^{22}Na^{+}$, the magnitude of the removal being slightly less than for the $^{137}Cs^{+}$ case. In cases where the ion of interest was present in macroconcentrations ($^{42}K^{+}$, $^{22}Na^{+}$ and $^{35}SO_4^{-2}$), removals fell in the range 0.15% to 20%. The ionic composition of the aqueous phase significantly influenced the magnitude of the removals. A linear relationship between electrophoretic mobility of the hydrous oxides and alkali metal cation removal was observed. Analysis of the data indicated that the hydrous oxides could be treated as variable capacity ion exchangers. The electrophoretic mobility could then be viewed as an index of the exchange capacity of the ion exchanger. Results were also interpreted in terms of a colloidal micelle model and it was possible to assign locations in the micelle to various ions. X-ray diffraction spectra were obtained for the hydrous oxide samples at adjusted pH values in the pH range 3 to 12. These spectra suggested that the freshly prepared hydrous oxides were amorphous. (Disser. Abstr.)

14582 METHOD OF SEPARATING OF SILICON ISOTOPES USING SILICON DISULFIDE AS THE FEED MATERIAL. Davis, William C.; Sheridan, C. W.; Tracy, J. G. (to United States Atomic Energy Commission). U. S. Patent 3,365,573. Jan. 23, 1968.

This patent describes an electromagnetic method of separating silicon isotopes wherein silicon disulfide is used as the feed material.

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 14601, 14691–14693, and 14696.

14583 ULTRA-LOW LEVELS OF TERRESTRIAL IONISATION. Liboff, A. R.; Shamos, M. H. (New York Univ., N. Y.). Nature (London), 217: 629-30(Feb. 17, 1968).

It was suggested in 1957 that the approximate lower limit of the exposure rate resulting from soil radioactivity be taken as 1.4 μR/hr. Subsequent surveys have reported minimum values for the intensity of terrestrial ionisation averaging ~4.5 μR/hr. Lowest indoor gamma levels, as measured in wooden houses, were reported as ~5.5 μR/hr. A value reported at Copperopolis, California, in 1962 by the Health and Safety Laboratory of the USAEC was 1.6 μR/hr, while that at a nearby asbestos mine was 0.5 μR/hr. Measurements were made in 1965 at the Red Mountain magnesite mine in the Diablo Mountains in California, and found a value of 0.05 μR/hr (±100%). Other asbestos mines also showed far less than normal exposure rates. Underground salt mines also showed rather low radiation levels. These results, and others, are shown in tabular form. The ultralow levels are almost certainly associated with ultramafic rocks, in which concentrations of U, Th and K are practically nil. The fact that relatively large regions show ultralow radioactivity may have significance in connection with the hypothesis that the mantle immediately below the Mohorovicic discontinuity consists chiefly of ultra basic rock, and the fact that there are probably severe restrictions on the absolute concentrations of radioactive elements existing in the Earth's upper mantle. An interesting aspect is the possible exploitation of such areas for research requiring extremely low backgrounds. (UK)

14584 RADIUM DETERMINATION IN THE MINERAL WATER SPRINGS OF ROMANIA. RADIOACTIVE UNBALANCE OF ELEMENTS IN THE URANIUM SERIES. Atanasiu, G. Stud. Cercet. Geol., Geofiz. Geogr., Ser. Geofiz., 4: 263(1966). (In French).

The ^{226}Ra content in several solutions of natural mineral waters was measured. Water concentration through evaporation ran from 2 to 25 times. Before analysis, the investigated solutions were kept in closed containers for at least 30 days in order to yield a Ra/Rn equilibrium. The Ra concentration was derived by measuring the quantity of Rn in a state of equilibrium. The method of circulation with an ionization chamber electrometer was used. In the analyzed waters, the Ra concentration ranged from 1.10^{-12} to 40.10^{-12} g Ra/l. Measurements were made to avoid errors which could interfere in the analysis of such minute Ra quantities. A comparison between ^{226}Ra/^{222}Rn ratio in the same spring reveals the radioactive unbalance of elements in the uranium series. The causes of this unbalance are emphasized. The presence of ^{226}Ra in the sediments where springs are located allows for the radiodating of these deposits. (Rom. Sci. Abstr.)

14585 MICROSCOPIC OBSERVATION OF RADIATION EFFECTS IN SOLID ORGANIC MATERIALS. Jedwab, Jacques. pp 189-96 of Advances in Organic Geochemistry, 1964 Proceedings of the International Meeting in Rueil-Malmaison. Oxford, Pergamon Press, 1966. (In French).

Optical properties of irradiated carbonaceous materials are discussed. The halos around radioactive inclusions correspond to induration and optical anisotropy regions, and are generally related to the paths of α particles. Photographs often show a dark halo interposed between the inclusion and the light halo. Such regions exhibit some stability with respect to metamorphic and tectonic action. Several materials are reported, and the photographic study reproduced: asphaltized wood, Temple Mountain, Utah; asphaltic blende of Mas Alary, France; coal, St. Hippolyte, Vosges, France; coal, Dorenaz, Valais, Switzerland; and cupriferous schist, Mansfeld, Germany. Characteristics of the halo may be used in the study of the evolution of solid organic material and the sedimentation of U. Sensitivity to irradiation of organic materials is apparently greatest at the early stages. Relative chronology of movements and irradiation periods may be determined in some cases. The mode of U deposition can be studied by the observation of halos minerals, and radioactivity. (BBB)

14586 ON THE INFLUENCE OF MULTIDISPERSION IN X-RAY RADIOMETRIC LOGGING. Meier, V. A.; Nakhabtsev, V. S. Vestn. Leningrad. Univ., Ser. Geol. Geogr., No. 12, 83-8 (June 1967). (In Russian).

A method to decrease the influence of the elemental composition of the medium under study in x-ray radiometric logging on the basis of the spectral ratio η_0 in surrounding rocks is given. It is established that the method of normalization to η_0 also decreases the influence of some other factors, complicating the quantitative interpretation of observed data. Some results of model experiments and field observations on lead-barium deposits are given to illustrate the practical possibilities of the method. (auth)

14587 ACCOUNTING OF THE ELEMENTAL COMPOSITION OF THE MEDIUM UNDER STUDY IN X RAY RADIOMETRIC LOGGING. Meier, V. A.; Nakhabtsev, V. S.; Kudryavtsev, Yu. I. Vestn. Leningrad. Univ., Ser. Geol. Geogr., No. 12, 73-82(June 1967). (In Russian).

An experimental method of investigating the influence of multidispersion in x-ray radiometric logging is considered. The method is based on the different dependence of intensity of single- and multidispersed rays upon the quantity of the heavy element. The contribution of multidispersion due to ^{75}Se and ^{170}Tm is calculated. It is shown that the influence of multidispersion within the interval of energy up to 100 keV may be considerable and should be taken into account while choosing radioactive sources and the geometry of measurements. (auth)

Meteorology

Refer also to abstracts 14468, 14697, 15310, and 16360.

14588 (HASL-184(App.)) FALLOUT PROGRAM. Quarterly Summary Report, September 1–December 1, 1967. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1, 1968. 204p. Dep. CFSTI.

Data tabulations are presented on monthly deposition of ^{89}Sr and ^{90}Sr at world land sites for the period 1957 to 1967; monthly deposition of fission products and activation product radioisotopes at selected US sites for the period 1957 to 1967; radiostrontium deposition at Atlantic Ocean weather stations for the period 1963 to 1967; radiostrontium in New York City milk and tap water for the period 1954 to 1967; a table of conversion factors; and a table of radioisotopes of interest in the fallout program with their half-lives. (R.C.K.)

14589 RADIATION IN THE RAIN IN KUMAMOTO DISTRICT. I. Yamashita, Tairi; Momoi, Tsuneo (Kumamote Univ., Japan). Kumamoto Daigaku Kyoikugakubu Kiyo, 14: 4-9(Mar. 1966). (In Japanese).

In connection with the communist Chinese nuclear tests in October 1964 and May 1965, respectively, a study and investigation were made in the Kumamoto district of the radioactivities in rainwater, decays and species of radioactive particles, and also on the reliability of the Hunter–Ballou's method of estimating the date of a nuclear test from the data. In both nuclear tests, high radioactivities were detected immediately after the test, which reduced gradually with the lapse of days. The rate of decrease in the activities was larger in the latter test than in the former. This was thought to be due to the prevailing meteorological conditions, rather than the species of radioactive particles. In the earlier stage of fallout, the tendency appeared that some nuclides predominated in the overall activity of a collected sample. It was found for Hunter–Ballou's method that it would give a fairly good indication of the date of a nuclear test if samples of high count rates were obtained and adequate data used. (NSA of Japan)

14590 RADIOACTIVE AEROSOLS AND VAPOURS. Chamberlain, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Contemp. Phys., 8: 561-81(Nov. 1967).

Radioactive substances may be present in air as dust, fume or vapor, very often attached to natural aerosols. Many nuclides are produced in the upper atmosphere by the interaction of cosmic rays and atmospheric gases, and as a result of nuclear bomb tests. Radioiodine has also been released accidentally from nuclear reactors. Radioactive vapors and aerosols were used to study mass-transfer between airstreams and surfaces. The results are applicable to problems such as the travel and deposition of spores and pollen. (auth)

14591 ^{131}I CONCENTRATIONS IN AUSTRALIAN MILK RESULTING FROM THE 1967 FRENCH NUCLEAR WEAPON TESTS IN POLYNESIA. Bonnyman, J.; Duggleby, J. C. (Commonwealth X-Ray and Radium Lab., Melbourne). Aust. J. Sci., 30: 223-6(Dec. 1967).

Iodine-131 introduced into Australian milk by the French nuclear weapons tests of June 6 and 28, and July 3, 1967, in Polynesia, was

measured. As a part of the fallout monitoring program, a daily sampling of cow's milk being consumed in eight major population centers throughout Australia was instituted. The milk samples were forwarded to the Commonwealth X-Ray and Radium Laboratory where they were assayed for ^{131}I. It was found that the time interval between the processing of whole milk by manufacturers of dried and evaporated milk products and the ultimate consumption of the milk derivative by a child is such that any ^{131}I in the original milk will have decayed completely. (R.C.K.)

14592 FALLOUT OVER AUSTRALIA FROM NUCLEAR WEAPONS TESTED BY FRANCE IN POLYNESIA DURING JUNE AND JULY 1967. Gibbs, W. J.; Moroney, J. R.; Stevens, D. J.; Titterton, E. W. Aust. J. Sci., 30: 217-22(Dec. 1967).

The external γ-radiation doses, integrated to infinity, from fallout at each Australian station from June to August 1967, computed from the measured daily total β activities are summarized. The fission products in the fallout giving rise to these external γ-radiation doses ranged in age between two and nine weeks. It follows that rather more than 70 percent of the total radiation dose from the fallout deposited would occur within a year of the explosions allowing a straightforward comparison to be made between these external γ doses and the annual background radiation from natural sources. The highest γ dose calculated for the fresh fallout detected in the Australia-wide network during the period was 0.3 mrad at Lae. Shielding and other factors would reduce the actual whole body doses by a factor of 2 or 3. The whole body dose actually received as a consequence of the fallout in the Lae area would be of the order of one-thousandth of the average annual background radiation of about 100 mrad. Estimated radiation doses to thyroid glands of young children consuming fresh cow's milk following fallout over Australia of fresh fission products from the 1967 series of nuclear weapons tests in Polynesia are summarized. In the major population centers, the radiation doses to thyroid were 16 mrad or less; the highest was in Perth and the lowest in Tasmania and Melbourne. The radiation dose to thyroid computed for Malanda milk is notably higher at 120 mrad than for other centers monitored. However, most of this milk is distributed over considerable distances from Malanda, resulting in delays of three to five days before it is consumed. Thyroid doses for young children consuming the milk in distant areas would be in the range 70 to 90 mrad. In November 1965, the Australian National Radiation Advisory Committee adopted a radiation protection guide for ^{131}I in fallout from nuclear weapons tests. The NRAC believed that the radiation dose to the thyroid incurred by drinking milk containing 200 pCi $^{131}I/l$ averaged over a year would not constitute a significant threat to the health of the Australian population. Estimated radiation doses to the Australian population from fallout from all nuclear weapons tested by France in Polynesia to date were tabulated. (F.S.)

Mineralogy and Exploration

14593 (RME-145) GRADE COMPUTER PROGRAM FOR CALCULATING URANIUM ORE RESERVES. Scott, James H. (Grand Junction Office (AEC), Colo. Production Evaluation Div.). July 1963. 25p. Dep. CFSTI.

The GRADE computer program enables a digital computer to calculate uranium ore reserves for underground mines at one or more selected cut-off grades ranging from 0.00 to 0.30 percent U_3O_8. Input sample data may be in the form of gamma-ray log readings or assays of samples from drill holes or channels. Sample data must be grouped first into separate mining levels and then into separate ore blocks within levels. Sample data and certain control information are keypunched on IBM cards. Both the sample data and GRADE program cards are subsequently submitted to the IBM 7090 computer center where the information on the cards is transferred to magnetic tape prior to machine analysis. During a computer run the GRADE program analyzes input data and develops the following information on a block-by-block basis for each selected cut-off grade: minable block area in square feet; average mining thickness of each block; tonnage; average grade; and pounds U_3O_8 contained in the ore. Totals and averages for all blocks are printed after the block-by-block printout for each cut-off grade. If more than one level or property is run at one time, a summary is printed showing totals and averages for all levels or properties. Data in the summaries also are plotted graphically to demonstrate how reserves are affected by changes in cut-off grade. Using the GRADE program the 7090 computer generates ore reserve information at a rate of about 800 holes (or channels) per minute per cut-off grade. Thus, if ten cut-off grades are run, the rate is about 80 holes (or channels) per minute. The machine performs arithmetic and logical operations set forth by the program, and prepares magnetic tape containing output information that is printed off line. The methods of reserve computation used in the GRADE program are parallel, if not identical, to hand methods that have been accepted as being valid and reasonably accurate. (auth)

Oceanography

Refer also to abstract 14695.

14594 (RLO-1725-85) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1964. VOLUME I. BROWN BEAR CRUISE 341: 11-27FEBRUARY. OSHAWA CRUISE 5: 13-25 FEBR UARY. BROWN BEAR CRUISE 345: 7-10 JUNE. Technical Report No. 180. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). Dec. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 211p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during cruises 341 and 345 of the Research Vessel Brown Bear and Cruise 5 of the Canadian Naval Auxiliary Vessel Oshawa during the months of February and June 1964 in an area within 175 nautical miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the properties, distribution, and movement of the Columbia River effluent water in the Northeast Pacific. (auth)

14595 (RLO-1725-86) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1964. VOLUME II. BROWN BEAR CRUISE 344: 18 MAY-5 JUNE. BROWN BEAR CRUISE 349: 7-31 AUGUST. OSHAWA CRUISE 6: 15-28 OCTOBER. . Technical Report No. 180. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). Dec. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 266p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during cruises 344 and 349 of the Research Vessel Brown Bear and Cruise 6 of the Canadian Naval Auxiliary Vessel Oshawa during the months May to October 1964 in an area within 800 nautical miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the properties, distribution, and movement of the Columbia River effluent water in the Northeast Pacific. (auth)

14596 (RLO-1725-87) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1964. VOLUME III. BROWN BEAR CRUISE 346: 12-20 JUNE. BROWN BEAR CRUISE 347: 21 JUNE-1 JULY. BROWN BEAR CRUISE 351: 15-29 SEPTEMBER. Technical Report No. 180. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). Dec. 1966. Contracts AT(45-1)-1725; Nonr-477(10); Nonr-477(37). 310p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during cruises 346, 347, and 351 of the Research Vessel Brown Bear during the months of June and September 1964 in an area within 100 nautical miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the properties, distribution, and movement of the Columbia River effluent water in the Northeast Pacific. (auth)

14597 (RLO-1725-91) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1965. VOLUME I. BROWN BEAR CRUISE 352: 11-28 JANUARY. BROWN BEAR CRUISE 357: 14-28 APRIL. BROWN BEAR CRUISE 368: 4-22 AUGUST. BROWN BEAR CRUISE 380: 3-18 NOVEMBER. Technical Report No. 182. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). Feb. 1967. Contracts AT(45-1)-1725; Nonr-477(37). 330p. Dep. CFSTI.

Tabulated physical, chemical, and biological data collected during cruises 352, 357, 368 and 380 of the Research Vessel Brown Bear during 1965 in an area within 650 nautical miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the properties, distribution, and movement of the Columbia River effluent water in the Northeast Pacific. (auth)

14598 (RLO-1725-92) PHYSICAL, CHEMICAL, AND BIOLOGICAL DATA FROM THE NORTHEAST PACIFIC OCEAN: COLUMBIA RIVER EFFLUENT AREA, 1965. VOLUME II. BROWN BEAR CRUISE 353: 9-19 FEBRUARY. BROWN BEAR CRUISE 354: 19-26 MARCH. BROWN BEAR CRUISE 355: 29 MARCH-6 APRIL. BROWN BEAR CRUISE 356: 9-12 APRIL. BROWN BEAR CRUISE 365: 11-20 JUNE. BROWN BEAR CRUISE 367: 2-7 JULY. BROWN BEAR CRUISE 371: 14-26

SEPTEMBER. Technical Report No. 182. Barnes, Clifford A. (Washington Univ., Seattle. Dept. of Oceanography). Feb. 1967. Contracts AT(45-1)-1725; Nonr-477(37). 320p. Dep. CFSTI.

Tabulated physical, biological, and chemical data collected during cruises 353, 354, 355, 356, 365, 367, and 371 of the Research Vessel Brown Bear during 1965 in an area within 100 nautical miles of the coasts of Washington and Oregon are presented. These data were collected as part of a year-round study to determine the properties, distribution, and movement of the Columbia River effluent water in the Northeast Pacific. (auth)

Seismology

14599 (NVO-1163-130) AMPLIFICATION OF SEISMIC BODY WAVES BY LOW-VELOCITY SURFACE LAYERS. Davis, A. H.; Murphy, J. R. (Environmental Research Corp., Alexandria, Va.). Dec. 19, 1967. Contract AT(29-2)-1163. 77p. Dep. CFSTI.

A theory is developed to predict the amplification of seismic body waves by a layer of alluvium. The theory is based on a model consisting of a single layer of alluvium lying above an infinite half-space of hardrock, with seismic waves incident from below. The amplification factor, defined as the ratio of the amplitude spectrum of the signal at the surface of the layer to the amplitude spectrum of the signal at a hardrock surface without any layer, is compared with observations made at two sites where such signals are available. The main body wave resonance of the layer can be predicted with fair accuracy. Suggestions for further studies and recommendations for additional instrumentation at favorable sites are included. (auth)

14600 ELIMINATING FALSE ALARMS WHEN DETECTING SEISMIC EVENTS AUTOMATICALLY. Muirhead, K. J. (Australian National Univ., Canberra). Nature (London), 217: 533-4 (Feb. 10, 1968).

One of the principal difficulties in using the full capabilities of a seismic array and digital computer for the automatic detection of seismic events is the number of false alarms produced by spurious noise spikes on single channels. Various methods of overcoming this problem have been suggested. A technique is described which not only reduces susceptibility to spurious noise, but appears to improve the signal-to-noise ratio and the array resolution. The mathematical process involved employs the n'th root of the absolute value of each individual signal, with the original sign preserved before phasing and summation. Comparisons of this method with the normal phased summation technique are shown graphically. It is suggested that the character of seismic background noise is not stationary for small intervals of time and that the process described tends to equalize the variance of this noise. (UK)

ENGINEERING

Nuclear Explosions

14601 (PNE-509) PRESHOT GEOLOGIC AND ENGINEERING PROPERTIES INVESTIGATIONS: PROJECT PRE-SCHOONER II. Lutton, Richard J.; Girucky, Frank E.; Hunt, Richard W.; Curro, Joseph R. Jr. (Army Engineering Waterways Experiment Station, Vicksburg, Miss.). Oct. 1967. 112p. Dep. CFSTI.

The Pre-Schooner II site was selected, from five areas investigated, on the basis of refraction seismic surveying, core drilling, and surface mapping in extrusive igneous rock that generally models the nearby Schooner site. Bedrock below about 5 feet of stony silt consists of a 25-foot-thick layer of vitrophyre and vitrophyre breccia over felsite that extends to a depth of at least 150 feet. These two bedrock layers at the site have distinctly different physical properties, the felsite being relatively less porous and stronger in compression than the overlying vitrophyre. The felsite is massive at depth, although highly fractured, but it becomes steeply flow-layered in the upper portion. The flow layers continue across a gradational zone into the overlying vitrophyre. The resultant structure strikes about north 35 degrees east. The felsite is conspicuously jointed, and the vitrophyre contains abundant microscopic cracks. (auth)

14602 HOW NUCLEAR EXPLOSIONS CAN BOOST GAS-STORAGE CAPACITY. Atkinson, Charles H.; Ward, Don C. (Bureau of Mines, Bartlesville, Okla.). Oil Gas J., 64: 102-5(Aug. 22, 1966).

The need for gas-storage capacity near metropolitan areas opens new fields of study as part of the Plowshare program. Results show that the cost of storing gas in cavities formed by nuclear explosives will be less than for liquefied natural gas or mined cavity storage. Under current study are problems which may arise from radioactivity and seismic shock, and the feasibility of a field test. (auth)

14603 OIL, GAS PROJECTS PERK UP AEC'S PLOWSHARE. Chem. Eng. News, 45: No. 6, 44-6(Feb. 6, 1967).

The economics of the AEC's Plowshare Project Gasbuggy is outlined and the industrial potential for the nuclear fracturing technique for natural gas recovery is reported. The engineering progress at the Pictured Cliffs formation is briefly described. Projects scheduled to follow Gasbuggy are Dragon Trail, Bronco, Sloop, and Ketch projects. (J.C.W.)

Facilities and Equipment

Refer also to abstracts 14721, 14722, 14730, 14745, 15144, 15262, 15393, 15482, 15496, 15501, and 15502.

14604 (AI-CE-46(Add.)) HEAVY WATER ORGANIC COOLED REACTOR. DEVELOPMENT OF SAP-STEEL PRESSURE TUBE TRANSITION JOINTS FOR THE HWOCR. Addendum. Sanders, M. K. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Jan. 15, 1968. Contract AT(38-1)-430. 7p. Dep. CFSTI.

The development and out-of-pile hydraulic loop testing of hot pressed and rolled transition joints between sintered aluminum powders (SAP) and stainless steel are discussed. The rolled joint is a sandwich type joint with SAP rolled between inner and outer stainless steel sleeves. Tensile data show that such joints are stronger than the SAP pressure tube, both in the as-bonded condition and after an equivalent stress relaxation life of better than 30 yr. Loop tests showed the feasibility of fabricating SAP pressure tube assemblies using both rolled and hot pressed joints. (F.S.)

14605 (BNWL-637) SODIUM REMOVAL AND CLEANING OF REUSABLE HARDWARE. Chulos, Leo E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 12p. Dep. CFSTI.

Experiments were conducted to determine the efficiency of an alcohol-base commercial solvent, Dowanol-EB, for removing sodium from contaminated reusable hardware. The cleansing procedure is described. The results showed that Dowanol-EB provides a safe and flexible method for cleaning reusable parts contaminated with sodium and sodium oxide; that the reaction rate of sodium with Dowanol-EB can be regulated by water additions; and that the end products, liquid and residue, can be readily dissolved and flushed with water. (L.C.L.)

14606 (CONF-671011-, pp 284-313) ANALYSIS, DETECTION, AND CONTROL OF FAILURES IN MECHANICAL EQUIPMENT. Sternlicht, Beno (Mechanical Technology Inc., Latham, N. Y.).

It is noted that most system failures can be traced to malfunction of a relatively few components such as bearings, gears, seals, and pistons. An approach to improved reliability by improved design based on analysis of key component failure causes is presented. Illustrations of the analysis technique as applied in failures associated with lubrication and wear are presented along with analysis techniques based on vibration and noise. Methods of failure control are discussed. (J.R.D.)

14607 (CONF-671011-, pp 314-39) MECHANICAL SIGNATURE ANALYSIS: A NEW TOOL FOR PRODUCT ASSURANCE AND EARLY FAULT DETECTION. Weichbrodt, Bjorn (General Electric Co., Schenectady, N. Y.).

Sound and vibration signals have been useful for many years in judging the internal condition of machinery and structures. The interpretation of sound and vibration signals is being developed from an art into a scientific technique known as Mechanical Signature Analysis, in which external measurements of sound and vibration signals are used to diagnose internal condition or malfunctions and to detect incipient failure. Mechanical Signature Analysis has great potential as a unique tool for increasing the reliability and maintainability of a wide range of components, assemblies, and systems. (auth)

14608 (ORNL-TM-2044) EXPERIENCE WITH MAY PACKS IN THE NUCLEAR SAFETY PILOT PLANT. Parsly, L. F. Jr. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 36p. Dep. CFSTI.

May packs have been used to collect fission product samples. Problems of May pack use include possible loss of efficiency by silver-plated copper screens in the presence of 100 + % relative humidity, and excessive deposition of particulate material in inlet check valves when sampling steam-air mixtures. The latter possibly happens because the valve surfaces are wetted by condensate. (auth)

14609 (SZS-14/67) RICHTLINIE FUER BAU UND AUSRUESTUNG VON LABORATORIEN FUER DEN VERKEHR MIT RADIOAKTIVEN STOFFEN. (Rules for Construction and Furnishing Laboratories for Traffic in Radioactive Material). (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1967. 42p. (In German).

Guidelines are given for the design, construction, and equipping of laboratories for work with radioactive materials. The necessary measurement areas, storage rooms for radioactive materials and wastes, animal stalls, and areas for radiotherapy and diagnostics are considered. The legal determinations and protective regulations for work with radioactive materials are given. The guidelines are not valid for mobile laboratories. (tr-auth)

14610 EFFECTIVENESS OF SPARK CONNECTION FOR REACTORS DESIGNED FOR LIMITING INTERNAL SURGES. Gusev, Yu. M.; Kadomskaya, K. P.; Levinshtein, M. L. (Leningrad Polytechnical Inst.). Izv. Vyssh. Ucheb. Zaved., Energ., No. 2, 12-18(1966). (In Russian).

The number of reactors connected to a line under conditions of internal surge limitation is generally greater than the number necessary for compensating line capacity during low power transmission. For this reason, some of the reactors are connected to the line through spark gaps to limit internal surges in long-range electric power transmission. The effectiveness of this type of reactor connection from the standpoint of its effect on maximum overvoltage is considered. Maximum overvoltage in switching commutation is a function of the following random quantities: the emf switching phase Ψ and the breakdown voltage of the reactor spark gap V_{br}. In plotting the distribution functions for the maximum overvoltages it was assumed that the emf switching phase Ψ is distributed according to a uniform density law in the interval from $-90°$ to $+90°$ inclusive. Curves are given for the resultant distribution functions for surges which result from line connection over a wide range of spark gap breakdown voltages. A comparison of the mathematical expectations for maximum surges with pulse switching for conventional and spark connection of reactors shows that reactors connected to the line through spark gaps may be treated as straight connections for practical purposes in power transmissions of higher classes of voltage with relatively low natural frequencies. The operating conditions of dischargers in circuits containing reactors with spark connection are analyzed. The results of the study show that operation of the discharger spark gap has practically no effect on the service life of the discharger even under emergency

conditions. The use of commutation dischargers behind the reactor spark gaps requires no special measures for preventing breakdown of the discharger spark gaps during operation of the reactor spark gap. (ATD)

14611 ANALYTICAL EVALUATIONS FOR THE OPTIMUM SELECTION AND ARRANGEMENT OF SHIELDING MATERIALS IN REACTOR SHIELDS. Schultz, H.; Sasse, S. (Technische Hochschule, Hanover). Nucl. Eng. Design, 6: 447-64(1967).

The designer of radiation shields is interested in an optimum selection and arrangement of shielding materials with respect to some optimization parameters as expenses, weight, thickness, etc. This becomes very difficult because of the complicated nature of the attenuation process and the complex linkage between the shielding characteristics in the various materials. The problems of such calculations are so complicated that generally a complete solution is not possible. Since the beginning of shielding theory, many efforts have been made to derive simplified calculations for this purpose with which at least a first approximation of the optimum conditions can be achieved. All previous studies concerning this matter are collected and discussed with respect to their applicability. (auth)

14612 HIGH-SPEED TIME ANALYZER. Nishino, Osamu (Tokyo Univ.). Volt (Tokyo), 18-20(Dec, 1965).

A high-speed time analyzer with a channel width of 0.1 to 10 μsec and a resolving time of 0.1 μsec was built to accurately measure the deceleration and diffusion of neutrons. The time analyzer of the parallel scaling type consists of a computing memory system containing 1400 diodes and 1500 transistors, a write-in system, and a read-out system. The computing memory system (the capacity is 17 bits for the 1st to 31st channels, and 22 bits for the last one) consists of a 32-channel scaler with 4 channels for the burst counting, and a total input counter. The write-in system consists of a 10 Mc clock generator, a frequency divider by which the frequency division ratio is determined in accordance with the input pulse height, and a synchronizing circuit by which the input pulse can be synchronized with the 10 Mc clock pulse with an accuracy of 2 nsec. The read-out system for the memory is so constructed that the operator can watch the memorizing process during measurement, and indications can be recorded as a strip chart and a printed data strip. The electric circuits for low speed flip-flop, read-out system, 10 Mc pulse generator, STC-frequency divider, and pulse synchronizer using Esaki diodes are also described in detail. (NSA of Japan)

14613 PERFORMANCE OF GAS MONITOR EMPLOYED AT FUEL REPROCESSING TEST PLANT OF JAERI. Sato, Nobuyuki; Minami, Kentaro (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 2: 76-80(June 1967). (In Japanese).

The first Japanese fuel reprocessing test plant was constructed at the JAERI in 1962 and this plant is scheduled to be in operation in the near future. The radioactive gases released from the plant are mainly iodine and krypton. Iodine is monitored by a special instrument with a charcoal filter paper and charcoal cartridges. The performance of a gas monitor designed to measure krypton-85 is described. In order to measure krypton-85 which emits 0.7 MeV β-rays, a gas sampler having a volume of 3.4 l was used with a bundle of two-sided window type G–M tubes. The minimum detectable amounts of this gas monitor obtained by calculation and experiment were of 2×10^{-7} μCi/cm^3 and 6×10^{-7} μCi/cm^3 respectively. (NSA of Japan)

14614 NA-2 NEUTRON GENERATOR AND ITS APPLICATIONS. Pasztor, E. (Central Research Inst. for Physics, Budapest). Isotopenpraxis, 3: 259-61(July 1967).

Modifications to the NA-2 neutron generator, developed for use in activation analysis, are described. Keeping the basic design concepts unaltered but utilizing the practical experiences obtained during this one-year period of operation, several modifications have been made in the construction to improve the operational parameters of the equipment. This improved type and its applications are described. (auth)

14615 USE OF IMPACT GENERATORS FOR PRODUCING PULSED MAGNETIC FIELDS WITH HIGH ENERGY CAPACITY. Arkhangel'skii, F. K.; Stolov, A. M. pp 165-8 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

An evaluation is made of the energy level delivered by a modern impact generator and a comparison is made of performance and economic data associated with this method and with the method of capacitive storage. The derived expressions for key parameters are applied to the evaluation of two specific impact generators: a Soviet mass produced three-phase impact generator with a cylindrical rotor as well as a special impact generator with eight poles developed by Siemens. The Soviet generator has a peak power of 2500 MW, with a model power of 125-150 MW while the Siemens generator has a model power of 300 MW. The analysis shows that in the machine version the value of the stored energy which can be achieved in practice is less than that achieved with capacitive storage. From the standpoint of useful life, the capacitive storage method is more efficient because the impact modes of generators are usually limited by a definite number of operations between replacements. Economic evaluation based on Soviet data shows that under equal conditions the cost per unit stored energy is 2 to 2.5 times less for the capacitive version. It is concluded that until special electromechanical storage generators are developed for the generation of strong pulsed magnetic fields, the condenser batteries are preferred. (ATD)

14616 ELECTROMAGNETIC PUMP. Yi, Jang. Tien Shih Chieh, 15: 412(Nov. 1962). (In Chinese).

A direct current electromagnetic pump suitable for the pumping of liquid metals used in atomic reactors is described. The pump is air-tight, constructed of metal, does not have a shaft, and does not require a lubricant. Its principal disadvantage lies in high sensitivity to air leakage during the circulation process. Another important disadvantage is its need for a low voltage, high amperage direct current. Other types of electric, electromagnetic and straight-line magnetic field induction pumps are described. (JPRS)

14617 INTERFACE STRESSES IN A COMPOSITE CYLINDRICAL SHELL UNDER RING LOADING. Yogananda, C. V. (Indian Inst. of Science, Bangalore). Nucl. Eng. Design, 6: 421-30(1967).

The problem of a two-layer circular cylindrical shell subjected to radial ring loading has been solved theoretically. The solution is developed by uniting the elasticity solution through Love function approach for the inner thick shell with the Flügge shell theory for the thin outer shell. Numerical work has been done with a digital computer for different values of shell geometry parameters and material constants. The general behaviour of the composite shell has been studied in the light of these numerical results. (auth)

14618 STRESSES AND DEFLECTIONS IN CIRCULAR PLATES WITH SQUARE PITCH PERFORATIONS. Harrop, J.; Abdul-Karim, R. M. (Univ. of Leeds, Eng.). Nucl. Eng. Design, 6: 431-9(1967).

Deflections and stresses developed in circular plates with square pitch perforations when the plates are subjected to uniform lateral pressure are considered. A method of calculating the stresses and deflections is developed based upon the elemental disk concept for the determination of the effective elastic modulus of the perforated zone. The proposed method of calculation is used to give results for comparison with experimental results obtained by other investigators on three plate models. (auth)

14619 USE OF CONCRETE IN NUCLEAR ENGINEERING. Lin, Hsien-hsiung. K'o Hsueh Ta Chung, No. 1, 9(Jan. 1962). (In Chinese).

It has been found that adding heavy mineral ores to concrete makes it a better shield to radiation. Adding 7 to 15 mm steel balls to concrete further enhances the shielding power of the mixed product. These types of concrete can be made out of materials widely available locally and are very useful in nuclear engineering. (JPRS)

14620 DESIGN OF RADIONUCLIDE LABORATORIES. Hughes, D. (Univ. of Leeds, Eng.). Chem. Brit., 4: 63-6 (Feb. 1968).

Some practical suggestions are made for the design of university laboratories in which open radioactive sources are used, with particular reference to floors, walls and ceiling, laboratory furniture, ventilation, fume cupboards, electrical and gas supplies, etc. (UK)

14621 PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON WATER DESALINATION, WASHINGTON, D. C., OCTOBER 3–9, 1965. VOLUME 3. Washington, D. C., Department of the Interior, 1967. 792p. GPO $3.75. (In Several Languages). (CONF-651005-(Vol.3)).

Forty-four papers on the design and economics of water desalination on systems are presented. Separate abstracts were prepared for three. Four appeared in NSA previously. For abstracts of these see CONF-651005 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 14622–14624.

14622 THE USE OF THE BELOYARSK AEPS POWER PLANT TYPE FOR DUAL-PURPOSE DESALINATION PLANTS. Koryakin, Yu. I.; Loginov, A. A.; Mikhan, V. I.; Monchinskii, A. G.

pp 87-96 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 3. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.3)).

The feasibility of using a graphite reactor of the Beloyarsk type for large dual-purpose power reactors for electric power production and water desalination was studied. The operating characteristics and economics of the system considering heat outputs of 520 and 1950 MW(t) are discussed. It was concluded that these reactors are very promising for such dual-purpose power plants. (L.C.L.)

14623 A REVIEW OF SOME EXPERIENCE IN THE DESIGN, MANUFACTURE, AND OPERATION OF SALINE WATER EVAPORATOR PLANTS. Leitner, Gordon F. pp 235-49 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 3. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.3)).

Experience in the design, production, and, in some cases, operation of desalination plants with capacities from 50 to 150 Mgd which use conventional fuels are summarized. Data on actual desalination plants illustrate the variations which were made in the basic flash-type evaporators to improve the cycle and to meet particular needs of individual commercial installations. Examples of vapor-compression type evaporators are also included for comparison. Based on the operating experiences described, water desalting is concluded to be practical and economical today in certain areas of the world. (L.C.L.)

14624 STUDY OF 150 MGD DESALTED WATER-POWER DUAL PLANT FOR SOUTHERN CALIFORNIA. Holtom, H. T.; Galstaun, Lionel S. pp 543-71 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 3. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.3)).

In 1964 the Metropolitan Water District of Southern California instituted a program to study the engineering and economic feasibility of using a nuclear power plant to produce 150 to 750 MW(e) power and 50 to 150 Mgd of desalinated water. Criteria for the cost, safety, siting requirements, and size of the plant were evolved. The conceptual design of the plant is described. The initial and operating costs are estimated. It was concluded that a dual-purpose nuclear power plant is both economically and technically feasible for water desalination in this geographic area and that three location sites are acceptable. (L.C.L.)

14625 PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON WATER DESALINATION, WASHINGTON, D. C., OCTOBER 3–9, 1965. VOLUME 1. Washington, D. C., Department of the Interior, 1967. 632p. GPO $3.25. (In Several Languages). (CONF-651005-(Vol.1)).

Thirty-four papers on water desalination are presented. Separate abstracts were prepared for three. Two appeared in NSA previously. For abstracts of these see CONF-651005 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 14626–14628.

14626 THE APPLICATION OF NUCLEAR POWER INSTALLATION FOR WATER DESALINATION WITH SIMULTANEOUS PRODUCTION OF ELECTRIC POWER. Dmitriev, I. D. pp 490-8 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 1. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.1)).

The USSR has developed three types of reactors for electric power generation: fast neutron, uranium–graphite, and water. Each is a possible source of inexpensive energy for dual-purpose power plants which could produce both electric energy and desalinated seawater. Process flow diagrams for each type of power plant are presented. The operating characteristics and economics of the systems are tabulated and discussed. (L.C.L.)

14627 NUCLEAR ENERGY: POTENTIAL FOR DESALTING. Ramey, James T.; Swartout, John A.; Williams, William A. Jr. pp 561-78 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 1. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.1)).

The economics and practicability of electric power generation from fossil-fueled and nuclear power plants are compared. The development of dual-purpose power plants for the production of both electricity and desalinated water is reviewed. The USAEC program on nuclear power plants for seawater desalination is described, and the factors affecting the cost of these plants are discussed. It was concluded that both fossil-fueled and nuclear power plants will be needed to meet the growing world's needs for energy and fresh water. (L.C.L.)

14628 COORDINATION OF INTERNATIONAL RESEARCH ON NUCLEAR DESALTING. Yagodin, G. pp 593-6 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 1. Washington, D. C., Department of the Interior, 1967.

See CONF-651005-(Vol.1)).

The role of the IAEA in promoting the use of nuclear energy for the desalination of seawater is described. Expected future developments in this field are summarized. (L.C.L.)

14629 PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON WATER DESALINATION, WASHINGTON, D. C., OCTOBER 3–9, 1965. VOLUME 2. Washington, D. C., Department of the Interior, 1967. 830p. GPO $4.00. (In Several Languages). (CONF-651005-(Vol.2)).

Fifty papers on engineering developments in water desalination are presented. Separate abstracts were prepared for two. (L.C.L.)

For abstracts of individual papers see: 14630 and 14631.

14630 LOW CAPACITY NUCLEAR DESALINATION PLANTS. Polushkin, K. K.; Koryakin, Yu. I.; Kuznetsov, S. P.; Grozdov, I. I., Sirotkin, A. P.; Loginov, A. A.; Khoroshavin, V. D.; Gasnikov, P. E.; Alekesenko, Yu. N. pp 499-510 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 2. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.2)).

A study of the problem of the impending construction of a nuclear low power desalination device, having acceptable engineering-economic indicators and sufficiently high operating characteristics, showed that nuclear devices with organic heat carriers satisfy all the requirements imposed on devices of a similar type. The high working capability of the entire basic equipment of a nuclear device with organic heat carrier was confirmed by experimental operation. The reactor of the desalination device may be built on the basis of existing elements and parts and, consequently, the production and operation of the entire equipment may be achieved in a sufficiently short period of time. The nuclear desalination device can be brought to the building site in the form of separate, fully-mounted mobile elements and blocks, the weight and size of which permit their transportation by various types of carriers. This offers the possibility of an autonomous utilization of nuclear desalination devices in different regions and significantly shortens the size and schedules of construction and mounting operations. (auth)

14631 GENERAL REVIEW OF THE WORK OF THE SEA WATER CONVERSION LABORATORY AT THE UNIVERSITY OF CALIFORNIA. Howe, Everett D. pp 301-15 of Proceedings of the First International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. Vol. 2. Washington, D. C., Department of the Interior, 1967. (In Several Languages).

See CONF-651005-(Vol.2)).

The principal findings of research programs on water desalination conducted by the University of California since 1961 are summarized. The experimental investigations included: basic studies of corrosion, properties of seawater, and thermoeconomic considerations; biological studies; distillation processes; electrodialysis; freeze separation; ion exchange; and nuclear heat sources. (L.C.L.)

14632 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Saunders, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,101,993. Feb. 7, 1968. Filed Aug. 11, 1964.

A fuel element assembly is described which is especially useful in a steam generating heavy water-moderated reactor. The fuel assembly consists of a cluster of end supported, spaced, parallel, sheathed fuel rods and at least one transverse bracing grid. The grid has a rim which is adapted by a skirt for resiliently engaging the inner wall surface of a liquid coolant conducting tubular member of a reactor core to deflect film flow of coolant from the wall surface. (F.S.)

14633 DATA RECORDING ACCESSORY CAMERA FOR MODIFIED POLAROID 95B CAMERA (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1641).

6 drawings.

A data recording accessory camera is described which is used with the modified Polaroid 95B in making Polaroid badge photo-

graphs. The photographs contain the identification picture and three lines of typed information photographed from an IBM card. (For details see TID-4100 Suppl. 43.) (F.S.)

14634 ROTATING TARGET (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1582).

43 drawings.

A rotating neutron target system and a conical and a spherical target are described. These are used with the 500-keV accelerator. The target system has a 30 to 40-hr half-life yielding 1 to 2×10^{12} neutrons/sec. The target rotates at 1100 rpm. (For details see TID-4100 Suppl. 44.) (F.S.)

14635 RF SEPARATOR (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1682).

25 drawings.

An rf separator device and its supporting structure are described. The separator was designed for the Stanford Linear Accelerator. The device makes it possible to form a beam that contains only electrons or positrons from a source beam that contains particles of different charges. The separation is accomplished by applying forces to the source beam which are transverse to its direction of flow. (For details see TID-4100 Suppl. 44.) (F.S.)

14636 CONCRETE DOOR FOR ACCELERATOR FACILITY (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1683).

23 drawings.

Heavy concrete shielding doors used at the beam switchyard, end stations, and air system at the Stanford Linear Accelerator are described. The doors act as radiation shielding blocks in a shield which surrounds a target area where there is a considerable amount of radiation. (For details see TID-4100 Suppl. 44.) (F.S.)

14637 FILM DRIVE FOR MOESSBAUER SPECTROMETER (Engineering Materials). (California Inst. of Tech., Pasadena). (CAPE-1460).

14 drawings.

A mechanical film drive is described. The drive is employed to move x-ray film used in the detection of γ rays in a Moessbauer spectrometer. (For details see TID-4100 Suppl. 44.) (F.S.)

14638 FATIGUE TESTER SERVO DRIVE CONTROL (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1468).

1 drawing.

The wiring diagram for the servo drive control for a high temperature fatigue tester is described. The tester is used to study material behavior under dynamic loads to minimize the risk of premature failure of reactor components at stress levels lower than those defined in terms of constant load conditions. The servo drive control consists of a Cycleflex Reset Timer, 360° limit switch, multi-rate speed reducer, $\frac{1}{75}$ hp synchro-motor, 1000 Ω potentiometer, 115 V power supply, transformer, and numerous diodes. (For details see TID-4100 Suppl. 44.) (F.S.)

14639 SAMPLING AND STORAGE FACILITY (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1661).

29 drawings.

Preparation for toll enrichment at the Oak Ridge Gaseous Diffusion Plant has included the construction of a uranium hexafluoride sampling and transfer facility which is described. The facility is located in a geographical position to permit access to uncleared personnel. Equipment involved is a steam-heated enclosure utilizing saturated steam, transfer piping, and the necessary cylinder handling hoists. At the present time, the facility is designed to handle cylinders up to the 2.5-ton, model 30-A size. The cylinder size limit will be extended to include the 10-ton model 48-A and 14-ton model 48-F cylinders. All systems provide maximum nuclear safety for the isotopic enrichments involved. Sampling and transfer between containers is performed with the UF_6 in the liquid phase. (For details see TID-4100 Suppl. 43.) (F.S.)

14640 DATA RECORDING ACCESSORY CAMERA FOR GRAFLEX 35MM PHOTORECORD CAMERA (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1640).

4 drawings.

A data recording accessory camera is described which is used with the Graflex 35 mm photorecord camera to make badge photograph negatives containing the identification picture and three lines of typed information photographed from an IBM card. (For details see TID-4100 Suppl. 43.) (F.S.)

14641 SPHERICALLY DESIGNED AIR-LUBRICATED SPINDLES (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-1627).

7 drawings.

Externally pressurized air-lubricated spindles are described which use porous graphite compensation. Two nearly hemispherical self-aligning bearings are used which simplifies fabrication and assembly and makes the air-bearing spindle competitive with ball-bearing spindles. The spindles are used on numerically controlled turning and boring machine tools. The spindles have optimum stiffness and thermal stability characteristics at a low-supply pressure and normal machining speeds and can be altered to produce spindles with optimum performance characteristics for other applications. (For details see TID-4100 Suppl. 43.) (F.S.)

14642 SUPERCONDUCTING MAGNET TEST FACILITY (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1654).

84 drawings.

A superconducting magnet test facility is described. The facility consists of the magnet, 24 in. test dewar, and the refrigerator. The magnet is capable of generating a central magnetic field intensity of 60 kG. The 24 in. helium dewar is wrapped in 3 in. of superinsulation and enclosed by a copper radiation shield. The shield is wrapped in 1 in. thick superinsulation. The assembly is contained in a vacuum jacket. Cooling is provided by a combination liquefier-refrigerator with a production rate of 51 liters/hr of liquid helium when used as a liquefier and a capacity of 240 W at 4.5°K as a refrigerator. The magnet and dewar are cooled with liquid helium. Approximately a liter of liquid helium is required to cool 2 lbs of magnet assembly from 77 to 4.2°K. (For details see TID-4100 Suppl. 43.) (F.S.)

14643 UO_3 PLANT (Engineering Materials). (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). (CAPE-1655).

41 drawings.

Equipment is described which is used in the conversion of depleted and enriched uranium nitrate solutions to UO_3. Included are the final concentrators, calciner, process engineering flow diagrams, nitric acid recovery system, and the electrical systems for the calciners and associated auxiliaries. (For details see TID-4100 Suppl. 43.) (F.S.)

14644 GLOVE BOX EVAPORATOR (Engineering Materials). (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). CAPE-1634).

4 drawings.

An evaporator, which may be used in a glove box, is described. It consists of a heat exchanger, thermowell, manifolds, and evaporator. The evaporator is $9\frac{1}{2}$ in. ID 2 ft 1 in. long and made of $\frac{1}{4}$ in. stainless steel contained in a 16 in. ID Sch 10 pipe. The heat exchanger is 30 in. long fabricated of Sch 10S pipe $5\frac{1}{2}$ in. ID, with a 10 in. dia flange. It contains 37 heat exchanger tubes of $\frac{1}{4}$ in. Sch 40S seamless pipe. (F.S.)

14645 SPARK-GAP TOOL SETTER (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant.). (CAPE-1628).

11 drawings.

An automatic tool setter is described which may be used with most machine tools requiring a high degree of accuracy in establishing tool position. A spark, between a probe or tool-setting station and the cutting edge of the tool establishes a point as a repeatable gap for tool positioning permitting parts to be machined to very close tolerances on a production basis. Electronic circuitry is reliable over long periods and is little affected by temperature or primary voltage changes. The equipment is not limited as to size and contains no moving parts to be damaged. Attaching the sensor to the fixture allows spindle-growth effects to be compensated for automatically. (For details see TID-4100 Suppl. 43.) (F.S.)

14646 ELECTROLYTIC POLISHING CONTROLLER SYSTEM (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1650).

19 drawings.

The control system for an electrolytic polishing cell is described. Incident light is piped to the specimen to detect any breakthrough in the dimpled region. If there is a breakthrough, the light is delivered through the hole to a photocell by a fiber-optics system. This system provides a small, intense light beam and eliminates interference from thermal fluctuations of the polishing solutions and radiation effects on the photocell. Activation of the photocell stops the polishing action. Extremely small holes can be detected. The system is rapid, and does not require the close attention of the operator. Radioactive materials may be

handled with little exposure and it is possible to go from bulk sample to finished specimen in 30 min. (For details see TID-4100 Suppl. 43.) (F.S.)

14647 CARBON BED LEAK DETECTOR (Engineering Materials). (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). (CAPE-1659).

6 drawings.

A leak detector using Freon-12 as a tracer is described for in place testing of installed carbon beds. The equipment case measures 31 by 2.2 by 13 in. and weighs ~90 lb. The Freon injection tube consists of stainless steel tubing (47 ft long by $^3/_{32}$ in. OD with 0.010 in. wall) which is used as an electrical resistance heater. A voltage of 115 V ac is applied across the length of the tube. Heat generated in the tube is used to heat the flowing Freon-12 from a liquid to a superheated vapor. The tube is electrically and thermally insulated. (For details see TID-4100 Suppl. 43.) (F.S.)

14648 CALUTRON SOURCES (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1656).

104 drawings.

The calutron type source is a source of 15 to 20 kV hydrogen ions. Ion current from the source is sufficient to produce a 50 mA beam of neutral hydrogen in a 10 cm^2 area four meters from the source. Hydrogen gas is admitted to the body of the source where it is ionized and then accelerated past electrodes to give the desired ion energy. After the ions leave the ground electrode they are deflected approximately 110° and focused into a nearly parallel beam of hydrogen ions. Beam deflection and focusing is accomplished by an electromagnetic field. The beam source assembly, shows one of the earlier calutron type source system assemblies. The grid source assembly and the accelerator decelerator source assembly are two sources which have been built and operated. (For details see TID-4100 Suppl. 43.) (auth)

14649 AUTOMATIC BALANCED FILTER DEVICE FOR X-RAY DIFFRACTION (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1680).

An automatic balanced filter box which may be used on most standard x-ray diffraction tubes is described. It is designed to be used in conjunction with a wide variety of automated x-ray diffraction experiments to change Ross filters and insert attenuators into the incident x-ray beam on receipt of appropriate commands from the control system. The positions of the filters and attenuators may be displayed at all times by using feedback signals generated by a combination of light sources and photocells. (For details see TID-4100 Suppl. 44.) (auth)

14650 KII ZONAL CENTRIFUGE (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1681).

22 drawings.

The KII high-capacity zonal centrifuge is described. The centrifuge was designed for purification of influenza virus at a rate (~100 1/8 hr day) which would make the instrument commercially feasible. The centrifuge operates with continuous-flow-with-banding using a tapered core with six vanes similar to the B-IX core (see CAPE-1415). The rotor has a single path fluid-line seal at each end eliminating any possibility of cross leakage between inlet and outlet streams. The maximum safe operating speed is 35,000 rpm. The drive system is a modified Barbour-Stockwell Co. Model 2501, 4 in. vertical turbine, with a maximum safe operating speed of 60,000 rpm. (For details see TID-4100 Suppl. 43.) (F.S.)

14651 MODINE COLD TRAPS (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1671).

84 drawings.

Cold traps are described whose function is to separate the UF_6 product from noncondensibles such as O, N, and F in the feed manufacturing process. This is achieved by operation of the traps at temperatures below the freezing point of the UF_6. In the primary trap, the trapping cycle operating temperature was 40 to 50°F based on operating conditions in the primary recirculating system. The secondary of back-up cold traps are operated at −50°F to reduce losses of U to an acceptable limit. Refrigeration of the primary traps is obtained from a chilled water system while the low temperature for the secondary system is obtained from expansion of carbon dioxide. The working inventory of the primary traps is ~25,000 lbs per cycle while the secondary traps normally hold from 2 to 3000 lbs. Trap inventory is removed by draining liquid UF_6 from the traps into approved product cylinders similar to those normally used for chlorine service. Liquid UF_6 is obtained by heating the traps to the condition indicated on the UF_6 solid-liquid phase diagram. During this step, it is frequently necessary to vent sorbed HF prior to drainage. (For details see TID-4100 Suppl. 44.) (auth)

14652 BEAM LINE LIQUID HELIUM CRYOPUMP (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1677).

30 drawings.

A beam line liquid He cryopump is described which is used for Alice (a neutral-injection, controlled thermonuclear machine). The pump prevents large quantities of H and other residual gases from entering into the ultrahigh vacuum environment for plasma. The pump consists of an annular tube through which a neutral energetic beam passes. The annular volume is connected to a He reservoir by insulated shielded lines. Thermal syphoning causes liquid He circulation from the annular pumping surface to the liquid He reservoir and eliminates gas pockets and hot spots on the pumping surface. The bare metal cryogenic pumping surface has a 4800 cm^2 area which can be subcooled to the Lambda point or lower. Hydrogen pumping speed measured at 2°K was 100,000 l/sec at a pressure of 8×10^{-10} torr. The heat leak was 0.75 W. (For details see TID-4100 Suppl. 44.) (F.S.)

14653 ELECTROPLATING UNITS (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-1664).

8 drawings.

Equipment is described which has improved electrodeposition efficiency (from 40 to 80%) for recovering U from urine. Electroplating time was reduced by 50% from 60 to 30 min. Operation is fully automatic following the addition of the urine solution to the electrodeposition cell and the application of power. (For details see TID-4100 Suppl. 44.) (F.S.)

14654 PIPING AND VENTILATION FOR HOODS (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-1679).

2 drawings

The piping and ventilation and a 4 in. hood control valve are described which are used with hoods in Pu fabrication. The piping drawing details the instrumentation and schematic system of the supply and exhaust connections of the inert gas control system. The 4 in. valve controls the exhaust flow necessary to sustain a negative pressure within the hood. (For details see TID-4100 Suppl. 44.) (F.S.)

14655 RADIANT HEAT FACILITY EQUIPMENT (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1674).

16 drawings.

Equipment used in the Radiant Heat Facility is described. The facility provides laboratory simulation of high temperature environments to study their effects on materials, components, and major assemblies. A wide range of thermal environments from high-level short duration programs to low-level long duration programs are simulated. Heater arrays using quartz infrared lamps are described consisting of gold plated reflectors, copper heat sinks, reflector back plates and lamp and sample holders. (For details see TID-4100 Suppl. 44.) (F.S.)

14656 DRUM DRYER MODIFICATIONS (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1663).

8 drawings.

Modifications are described for drum dryer units used to dry uranyl nitrate solutions. The modifications will increase production rates without any basic change in the method of operation. The changes will simplify dryer feeding process and the return of overflow solutions by eliminating a number of manual valves. (For details see TID-4100 Suppl. 44.) (F.S.)

14657 PULSED-ARC WELDER (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1686).

4 drawings.

A tungsten inert gas arc spot welder is described. Arc durations from 0.005 to 0.040 sec are available with peak current varying from 8 to 240 A. The welder is used to weld small wires and heat sensitive parts. Wires from 0.010 in. Al to 18 gage Cu can be welded and seam welds using a series of overlapping spot welds can be made. Weld energy is stored in electrolytic capacitors and the output wave form is modified by the insertion of inductors. (For details see TID-4100 Suppl. 44.) (F.S.)

14658 METALLOGRAPHIC GLOVE BOX FACILITY (Engineering Materials). (Mound Lab., Miamisburgh, Ohio). (CAPE-1687).

7 drawings.

A double-faced, stainless steel glove box, 21 ft long divided into eight double bays is described. The box is used for metallographic studies of Pu bearing materials. Continuously flowing N provides an inert atmosphere. The pressure in the glove box is completely

self regulating and automatically controlled. Each of the double-faced bays is separated by sliding doors which form partitions between the bay. Each bay has its own separate supply and exhaust line for ventilation. (For details See TID-4100 Suppl. 44). (F.S.)

14659 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS. (to General Dynamics Corp.). British Patent 1,103,124. Feb. 14, 1968. Priority date June 9, 1965, United States.

A fuel element is described which is used in high-temperature gas-cooled nuclear reactors. The fuel element consists of an elongated body of refractory materials divided into sections. Each section contains fuel particles completely covered with a coating of impervious material which will prevent fission product passage. The fuel element body sections are axially aligned and interengaged. (F.S.)

14660 TONGS FOR GRIPPING ARTICLES WITH COMPLETELY SMOOTH SURFACES. Dodemant, Jacques; Renaux, Charley (to Commissariat a l'Energie Atomique). British Patent 1,102,843. Feb. 14, 1968. Priority date Spet. 21, 1965, France.

Tongs are described which may be used for gripping articles which have completely smooth surfaces, and which cannot be gripped in the hand either because they are dangerous to handle or because they are difficult to reach, such as fuel elements submerged in water at a depth of several meters. The tongs have a tubular body provided at one end with a fixed and a pivoted jaw and a rod housed in and around the axis and adapted for movement. A control is provided for the pivoting jaw. Each jaw has at least one hard and one sharp gripping tip. A compression spring has one end connected to the jaw and the other to a hand grip outside the tubular body. Compression of the spring acts on the pivoting jaw so that the sharp tip of the jaw penetrates into the article to be gripped, and the article is then firmly lifted. (F.S.)

14661 PRESSURE RELIEF VALVE. (to Atomic Energy of Canada Ltd.). British Patent 1,102,908. Feb. 14, 1968. Priority date Aug. 9, 1965, United States.

A relief valve used in a nuclear reactor containment system is described. A reactor, housed in a building maintained at atmospheric pressure, is vented to a large vacuum building. If the pressure between the two buildings is equalized, pressure in both remains below atmospheric preventing the escape of radioactivity. The fast acting relief valve connecting the two structures is described. (F.S.)

14662 AN IMPROVED GRINDING MACHINE. Mills, John Penrose (to H. M. Hobson Ltd.). British Patent 1,098,730. Jan. 10, 1968. Filed Nov. 5, 1965.

A grinding machine is described which is used in profile grinding of fuel cans which are thin walled tubes. The machine may also be used in profile grinding for lands on solid or tubular rods. The machine consists of a profiled grinding wheel, workpiece carrier adapted to mount a cylindrical workpiece, mechanism for rocking the carrier to move the workpiece past the grinding wheel and a mechanism for rotating the workpiece. Grinding is completed as a result of a single pass of the workpiece past the grinding wheel. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 14715, 14717–14720, and 14725.

14663 (EUR-3733) DESCRIPTION OF IBM 360 COMPUTER PROGRAM FOR THE CALCULATION OF LIQUID COOLED 7-ROD CLUSTER FUEL ELEMENTS. Eifler, W.; Nijsing, R.; Airola, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 24, 1967. 32p. Dep.

An IBM 360 computer program for calculating the thermal performance of liquid cooled 7-rod cluster fuel elements is described, first for general features, then the single parts, and finally with a complete listing of the program. (L.C.L.)

14664 (KAPL-3358) A REVIEW OF TWO-PHASE LIQUID-VAPOR HYDRODYNAMICS AT LOW FLOW. Carr, J. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1967. Contract W-31-109-eng-52. 21p. Dep. CFSTI.

A review of the hydrodynamics of two-phase flow at low flow rates is presented. The flow oscillations, flooding, pressure drop, and dryout phenomena are discussed in relation to the cocurrent upflow, countercurrent flow, and cocurrent downflow modes that may exist. The analytical and experimental developments that are required to formulate a single analytical method spanning the cocurrent flow modes are roughly outlined. (auth)

14665 (ORO-3411-9) A STUDY OF THE OPERATING CHARACTERISTICS OF THE HEAT PIPE. Report on Progress During the Ninth Quarter. Ferrell, J. K. (North Carolina State Univ., Raleigh). Nov. 1, 1967. Contract AT(40-1)-3411. 13p. Dep. CFSTI.

The design of an experimental apparatus to study heat transfer to wetted porous beds at atmospheric and elevated pressures (up to 200 psi) has been completed and the apparatus is under construction. The solution technique for the distributions of pressure, mass flux, temperature and heat flux in a flat-plate heat pipe is discussed. (J.C.W.)

14666 (ORO-3411-10) CAPILLARITY IN POROUS MEDIA. Progress Report During the Tenth Quarter on A Study of the Operating Characteristics of the Heat Pipe. Ferrell, J. K.; Schoenborn, E. M. (North Carolina State Univ., Raleigh). Feb. 20, 1968. Contract AT(40-1)-3411. 17p. Dep. CFSTI.

Falling capillary equilibrium heights of water in porous media were determined under adiabatic and evaporative (boiling) conditions at atmospheric pressure. The packed beds consisted of stainless steel particles (40 to 100 mesh) and glass beads (80 to 100 mesh). For the glass beads, capillary heights were correlated as a function of the specific evaporation rate of the working fluid and found to be independent of evaporation rate over the range (0 to 50 lb/hr-ft^2) studied. The data were explained by assuming that the sole effect of imposing a heat flux on the porous media was to change the surface tension and density of the liquid water. The effect of reduced surface tension and density alone were sufficient to explain the observed results; apparently no change in cost θ/τ was affected by the imposition of the heat flux. (auth)

14667 (WAPD-TM-737) SOME NUMERICAL TESTS OF ELASTICITY SYNTHESIS. Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1967. Contract AT(11-1)-Gen-14. 11p. Dep. CFSTI.

The synthesis approximation, well known in the reactor theory field, has been applied to the problem of obtaining plane-strain material displacements induced by thermal gradients in two specific problems. A technique for choosing trial functions is presented which resulted in reasonable approximate synthesis solutions. The synthesized displacements are compared pointwise with two-dimensional finite difference solutions of the problems considered. (auth)

14668 (BNL-tr-176) HEAT TRANSFER STUDY OF BOILING MERCURY AND MAGNESIUM AMALGAMS UNDER NATURAL CIRCULATION CONDITIONS. Korneev, M. I. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Teploenergetika, 2: No. 7, 25-30(1955). 24p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Heat transfer from the wall to nonboiling and boiling mercury and mercury amalgams was studied experimentally, and factors influencing the heat transfer at boiling, such as surface purity, pressure, velocity of the liquid and vapor phases (in vertical and horizontal tubes), were examined. (auth)

14669 THREE DIMENSIONAL TEMPERATURE AND THERMOELASTIC STRESS FIELDS IN A HEAT PRODUCING SPHERE DUE TO ARBITRARY SURFACE HEAT TRANSFER. Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design, 6: 395-420(1967).

A method based on a truncated series of spherical harmonics is developed for the solutions of temperature and stress fields due to variable heat transfer over the surface of a sphere with a uniform heat source. The coefficients of the series are obtained by application of the least squares principle to the relevant boundary conditions. The method is applied to a number of heat transfer distributions of practical interest and results are plotted. Conclusions are drawn regarding the effect of various distributions on temperature and stresses and also regarding possible simplified treatment of complex distributions by consideration of the symmetry involved. (auth)

14670 TWO-PHASE HEAT TRANSFER IN HORIZONTAL TUBES. Rounthwaite, C. J. Inst. Fuel, 41: 65-76(Feb. 1968).

In evaporation equipment, boiling often takes place in horizontal tubes, and for the accurate determination of surface requirements a detailed knowledge of boiling heat transfer in appropriate tube configurations is necessary. Water/steam heat-transfer experiments were carried out in a horizontal "hairpin" type test-section tube, representing a portion of a full-sized element of a nuclear power station boiler. The test conditions were varied to cover the entire quality range at realistic pressures (200 to 950 psig), mass velocities (160 to 200 lb/sec ft^2), and heat fluxes (8,000 to 25,000) Btu/ft^2 hr). Local heat-transfer measurements at a large number of points on the test section enabled deductions to be made on two-phase flow patterns and heat-transfer mechanisms existing in the tube. The effect of gravity, producing asymmetrical conditions

across the tube-section, was observed under almost all conditions. These effects were particularly evident during dry-out on the tube wall—at qualities in excess of 90%—though at much lower qualities it was possible to have a complete segregation of the two phases across the tube-section. (auth)

Isotope Technology

Refer also to abstracts 14586, 14741, 14765, 14766, 14769, 14771–14783, 14825, 14880, 14881, 14892, 15191, and 16252.

14671 (COO-1616-7) COBALTOUS OXIDE. I. A COMPACT SINGLE LINE SOURCE. Mullen, James G.; Ok, Hang Nam (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1967]. Contract AT(11-1)-1616. 13p. (CONF-680107-1). Dep. CFSTI.

From 4th Moessbauer Symposium, Chicago, Ill.

Methods for preparing stoichiometric cobaltous oxide are discussed. Moessbauer patterns for CoO prepared 3 different ways are considered and the Debye temperature measured. Variations in structure of the products from the 3 methods of preparation are described. It may be possible to fabricate ^{57}CoO sources of 1 to 10 Ci activity without any appreciable electronic absorption. (M.C.G.)

14672 (K-1712) A DYNAMIC PROGRAMMING ALGORITHM OF THE UNITED STATES ^{235}U PRODUCTION FACILITIES. Kephart, W. L.; Copper, J. R.; Pritchard, T. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Feb. 13, 1968. Contract W-7405-eng-26. 72p. Dep. CFSTI.

A mathematical model of this production complex has been formulated to assist in conducting a more effective analysis of this economic system. Use of this particular model is not the only mode of analysis in this area of endeavor; however, it is one of the more comprehensive. Primarily, it is used to gain more insight into the encompassing environment and to provide a basis for further studies. The model is designed within the framework of dynamic programming and utilizes the backward algorithm with analytic stage solutions. The model simulates various economic situations and illustrates the diverse types of analyses produced. Special attention is given to the techniques used to minimize data handling, edit the input data, maintain a historical library of case results, and generate various types of reports. An automated technique devised to provide plots from data retained within the historical files is also reviewed. (J.C.W.)

14673 (MMM-3824-0013) SNAP-23A PROGRAM, PHASE I. THERMOELECTRIC CONVERTER DEVELOPMENT PROGRAM. Quarterly Report No. 3, July 1–September 30, 1967. Wachenheim, J. V. (Minnesota Mining and Mfg. Co., St. Paul). Contract AT(30-1)-3824. 91p. Dep. CFSTI.

The first four 10-couple modules were assembled and placed on long-term performance test and assembly was started for Experimental Mockup Converter number 1. Converter/system thermal interface definition was established. A design requirement specification was prepared for the Experimental Mockup Converter performance. Converter test plans and procedures were prepared. Thermoelectric material recharacterization was initiated. The 10-couple module test plan was submitted. Process and test stations (converter and 10-couple module) assembly are ninety percent complete. (J.C.W.)

14674 (ORNL-TM-1940(Pt.2)) SELECTED ABSTRACTS OF NON-U. S. LITERATURE ON PRODUCTION AND INDUSTRIAL USES OF RADIOISOTOPES. Gerrard, Martha; Baker, P. S. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 59p. Dep. CFSTI.

More than 575 abstracts of non-U.S. publications on production and use of radioisotopes and radiation, selected from the July–December issues of Nuclear Science Abstracts (1967) are presented. (auth)

14675 (ORO-658) AEC GASEOUS DIFFUSION PLANT OPERATIONS. (Atomic Energy Commission, Washington, D. C.). Feb. 1968. 45p. Dep. CFSTI. DTIE.

Information is provided on the physical features, operating requirements, economics, potential improvements, and capabilities of each of the three gaseous diffusion plants. The comparative economics of joint versus independent plant operations are discussed. Appendices include: a discussion of separative work as it relates to gaseous diffusion plant operations, the Commission's standard table of enriching services along with formulas used in developing the respective values, and criteria on uranium enrichment services in facilities owned by the AEC. (M.C.G.)

14676 (SC-DC-67-2119) NEW DEVELOPMENTS IN THE SPACE ISOTOPE POWER PROGRAM. Clark, Arthur J. Jr. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 32p. (CONF-680301-1). Dep. CFSTI.

From 5th Space Congress, Cocoa Beach, Fla.

The need for adequate sources of electric power in space missions is discussed. The development and performance or anticipated performance of SNAP-3, 9A, 19B, 27, 29 and a large heat source to provide the thermal input for the Brayton cycle power converter are described. Research on thermal insulation is also reviewed. (F.S.)

14677 (STI/PUB-139) STANDARDIZATION OF RADIONUCLIDES. Proceedings Series. Proceedings of a Symposium held in Vienna, 10–14 October 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 756p. (CONF-661012). IAEA: $15.00; Austrian Schillings 388,-; £ 5.5.10; F Fr 73,50; DM 60,-.

Separate abstracts were prepared for twenty-five of the sixty-eight papers presented. Forty-three papers were previously included in NSA. For abstracts of these papers see CONF-661012 in the report number index. (B.G.D.)

For abstracts of individual papers see: 14680, 14681, 14765–14783, 14825, 14826, 14880, and 14881.

14678 (STI/PUB-142) RADIOISOTOPE TRACERS IN INDUSTRY AND GEOPHYSICS. Proceedings Series. Proceedings of the Symposium held in Prague, 21–25 November 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 710p. (CONF-661121). IAEA: $14.50; S 375,-; £ 5.2.4; F Fr 71,10; DM 58,-.

Forty-seven papers on the use of radioisotope tracers in industry and geophysics are presented. Separate abstracts were prepared for 45. Two appeared in NSA previously. For abstracts of these see CONF-661121 in the Report Number Index. (L.C.L.)

For abstracts of individual papers see: 14682–14725 and 15191.

14679 (WANL-3800-9) SNAP-23A, PHASE 1. Quarterly Progress Report, September 1–November 30, 1967. Cerni, S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 15, 1967. Contract AT(30-1)-3800. 119p. (WANL-PR(SS)-010). Dep. CFSTI.

Progress is reported on SNAP-23A, the Advanced Terrestrial Radioisotope Power System. The radiator was received and put on thermal test. Tests indicate that the end-of-life power rejection can be accommodated at a maximum radiator base temperature of 150°F. The experimental mockup converter was assembled. Electron Beam welding was proposed for use in closure welding. Molybdenum–uranium, tungsten–nickel, and stainless steel shielding materials were evaluated for use with Sr and Co sources. Major components of the heat source are being assembled. Fabrication of Min-K-2000 thermal insulation was begun. The heat source support system and base assembly consisting of inner and outer insulation cans is ready for assembly. Heat source materials including Hastelloy-C/Ti/U–Mo/Cu/Inconel 718 and Hastelloy–C/Ta/U–Mo/W/Hastelloy C were tested. Properties of as cast U–Mo were determined. Thermal conductivity was determined for thermal insulation materials. A thermal analysis was performed to determine the effect of radiator damage on critical generator temperatures. It was found that about 75% of the radiator must be destroyed before a safety problem occurs. (F.S.)

14680 REFERENCE SPECTROMETRIC ALPHA SOURCES (RSAS). Khol'nov, Yu. V.; Aleksandrov, B. M.; Belyatskii, A. F. (Leningrad Radium Inst.). pp 473-85 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The basic parameters of reference spectrometric α-sources with a firmly attached layer of radioactive material are presented. The sources are produced from uranium-233, plutonium-238, plutonium-239, polonium-210 and thorium-228, and in a number of cases are covered with a thin film. The intrinsic half-width of the α-lines in no case exceeds 15 keV and in some cases is less than 2 keV. (auth)

14681 STABILITY OF STANDARD SOLUTIONS OF SOME RADIONUCLIDES. Zderadicka, J.; Jasanovsky, P.; Spanel, J.; Bucina, I. (Inst. for Research, Production, and Application of Radioisotopes, Prague). pp 657-61 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Methods for checking the stability of standard solutions of some radionuclides are described. Long-term stability (8 to 20 months) was studied with some commonly used radionuclides of long half-life. The losses onto the walls of the ampoules used as containers were studied directly. A sealed ampoule of stan-

dard solution was emptied and the liquid residue was removed by centrifugation. The activity of the radionuclide sorbed on the glass surface and diffused in the walls was measured either by means of a GM counter or by the scintillation method after the ampoule had been filled with a suitable scintillator. Results were corrected for the activity of the surface liquid film that remained in the ampoules even after centrifugation. Solutions with a carrier content in the range to 100 μg per gram of solution and with a pH in the range 0 to 2 were studied. The long-term losses determined were less than 0.02% for ^{90}Sr and less than 0.1% for ^{90}Y in equilibrium. For ^{147}Pm the losses were less than 0.2% and for ^{137}Cs less than 0.3%. The short-term stability of ^{210}Po was studied by analogous methods. With a tellurium carrier the losses were 1.2% after a storage time of between a week and a month and it was necessary to correct for them by use of a standard. (auth)

14682 SURVEY OF THE USE OF RADIOACTIVE TRACERS IN INDUSTRY. Postnikov, V. I. (Baumann Higher Technical Inst., Moscow). pp 3-18 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

A survey of industrial uses of radioactive tracers is described. Significant technological and economic results have been obtained by using radioactive tracers in machine construction, chemistry, food production, building and other branches of industry. The most successful use of tracers in machine construction is in the investigation and control of wear in instruments, components and mechanical parts. Activation methods have been developed and put into use in processes for measuring the thickness of layers in electroplating, the introduction of radioisotopes into smelting processes, general and local neutron activation, activation with accelerated charged particles, and other processes. Studies of wear in internal combustion engines, for example, allow one to determine within a short time the effect exerted on such wear by basic structural details and technological factors, operating conditions, lubricants with various additives, running-in time and many other factors. The investigations are carried out in testing units under operating conditions, without interruption or disassembling of the units under study. Studies of wear in machines and mechanical parts can reduce the expenditure of time and resources by a factor of 10 to 15 in the production of high-grade components with a long life, and work with instruments can reduce losses by a factor of nearly 50. In the food and chemical industries radioactive tracers are being used to study and control the flow of various technological processes. The use of tracers not only simplified the solution of many technological problems, but yields new information on how various parameters and types of equipment affect the process. One of the projects involving the use of radioactive tracers in the building industry is the optimization of the process of producing cement clinker by determining the rate of movement of material in the rotating furnace of a cement and slate plant. The use of radioactive tracers accounts for no less than 20% of the total savings resulting from the introduction of radioisotopes and nuclear radiation in industry. (auth)

14683 ROUTINE INDUSTRIAL USES OF RADIOACTIVE TRACERS. Beswick, C. K. (International Atomic Energy Agency, Vienna). pp 21-38 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Many radioactive tracer techniques have been developed to the stage where their routine use for industrial investigations is accepted. The most common of these routine techniques are described, and the extent of their use in particular industries is discussed. The successful introduction of radioisotope applications in any country depends to a very large extent on the type of organization which is formed to promote and apply these techniques. The ways in which radioactive tracer services are organized in different countries are summarized. (auth)

14684 INVESTIGATIONS OF PHENOMENA AFFECTING ENGINE WEAR BY MEANS OF RADIOACTIVE TRACERS. Fodor, J. (Inst. for Development of Vehicles, Budapest). pp 41-7 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Until now engine wear investigations have usually been made by studying only one of the wear factors or, at most, those thought to be important, but never by investigating all of them. Therefore, it has not been possible to evaluate the importance of different wear factors in relation to each other. The speed of radioactive tracer methods has made it possible to investigate all the important wear factors. Therefore, engine wear experiments were conducted for both test-bench and road conditions to determine the combined effect of the following variables on engine wear: quality of bearing material; lubricating oil quality; fuel quality as a function of sulfur content; working conditions; and the introduction of mechanical contaminants such as abrasives entering the engine with air, lubricating oil, and fuel. The results indicated that the mean engine life could be doubled by controlling the factors which contribute to engine wear. (L.C.L.)

14685 USE OF KRYPTONATED MATERIALS IN WEAR AND CORROSION REACTIONS OF INTEREST TO INDUSTRY. Chleck, D. (Parametrics Inc., Waltham, Mass.). pp 49-70 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The use of the kryptonate technique for the study of surface temperatures, chemical reaction rates and erosion is discussed as it pertains to wear and corrosion. Kryptonates are solids into which radioactive krypton has been introduced into a narrow surface zone. Once incorporated within the solid and stabilized at operating temperature, the krypton atoms appear to simulate the matrix atoms of the solid. A promising area of investigation lies in the study of surface temperatures and temperature profiles. Typical experiments are described for blades operated in gas turbine engines. Results indicate the ability to determine surface profiles within ±10°F at temperatures of 2000°F. Once temperature conditions are established a further loss in activity can be related to the erosion or ablation which occurs in the engine. The study of oxidation rates at elevated temperatures of various kryptonated metals is described. Krypton-85 can be used as a sensitive indicator at the onset of the reaction as well as following the progress of oxidation in later stages. Information about reaction mechanism and temperature coefficients can also be obtained. Preliminary investigations with the kryptonate technique for the direct measurement of wear are outlined. Thus, not only can the major factors contributing to the wearing process (i.e., surface temperatures and oxidation) be determined, but the total wear as well. Kryptonates can also be used to determine rapidly the corrosion rates of metals. The relative corrosion of two aluminum samples differing only in the extent of their heat treatment was measured within a two-hour period. (auth)

14686 A SPECIAL MEASURING METHOD OF EXAMINING SEVERAL COMPONENTS OF WEAR BY MEANS OF RADIOACTIVE ISOTOPES. Gerve, J. A. (Technische Hochschule, Karlsruhe, Ger.). pp 81-91 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Methods are developed to examine combustion engines by means of radioactive isotopes. With normal gamma spectrometry the wear of an iridium-alloyed cylinder liner and a cast-iron piston ring is measured continuously and at the same time. The cylinder liner and piston ring are activated by neutrons. To test the wear process of an engine carefully and quickly it is necessary to record the wear of more than three different parts of the engine at the same time. This condition cannot be met by normal gamma spectrometry for two reasons, the Compton scattering of gamma quanta of higher energy interferes with the detection of gamma quanta of lower energy; and the photopeaks of the gamma quanta of different radioactive isotopes overlap in whole or in part. With a special 4π-measurement device, a combination of symmetrical anti-Compton and sum-coincidence arrangements (a multicomponent measurement for gamma quanta) can be satisfactorily achieved. The measuring head of this special gamma spectrometer consists of six equal frustums of pyramids of NaI(Tl) with photomultipliers flanged on. The six scintillators are optically separated and enclose the measuring space. By this combined method gamma quanta with equal energies can be differentiated, on condition that part of the gamma quanta comes from a certain gamma cascade decay. The detection probability of the special 4π-measuring head essentially depends on the energy of the gamma quanta, on conversion coefficients, on the angular correlation of the quanta of cascade decays and on the thickness of the frustums of pyramids of NaI(Tl). The measuring system involves extensive electronic equipment to select the information according to pulse height and temporal correlation. This measuring system enables us to examine simultaneously: the wear of the chromed surface of a piston ring; the wear of the iron flank of the same ring; the wear of a second cobalt-alloyed piston ring; the wear of an iridium-alloyed cylinder liner; and the

wear of a specially marked place. The following is a typical detection efficiency: 10^{-9} g radioactive substance, equally distributed per cm^3 oil can be detected, giving 55 counts/min. The specific activity of the substance is 0.5 mCi/g and the energy of the gamma quanta 1 MeV. The measuring method outlined can also be applied to facilitate special chemical analyses and to observe complicated processes of metabolism. (auth)

14687 COMBUSTION-ENGINE WEAR STUDIES BY A RADIOACTIVE TRACER TECHNIQUE. Burianova, M.; Hejtmanek, K. (Motor Car Research Inst., Prague). pp 93-8 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The radiotracer technique was used to study the wear of internal combustion engines for passenger cars. In 1960 a laboratory was built for tests with radioisotopes. For five years examinations have been carried out under laboratory conditions on the test bench and on the road. Special attention was given to the most strained engine parts—top piston rings and crank bearings. The parts to be traced were irradiated in the reactor and the following gamma emitters were used: cast-iron piston rings contained the radioisotopes ^{59}Fe and ^{54}Mn, lead bearings with tin and antimony addition contained the radioisotope ^{124}Sb. The tests were made in four-cylinder spark ignition engines Skoda 990 and 993, of standard production. The measuring method consisted in detecting the amount of radioactive wear debris in the crankcase oil. The measuring equipment comprised a scintillation counter with a NaI(Tl) crystal for detecting gamma radiation and electronic counting instruments complemented by special accessories. In laboratory tests the activity of the oil is measured continuously during engine operation. In long duration performance tests periodic oil samples were drawn from the crankcase; samples and radioactive standards are measured in the same arrangement. When evaluating the rate of wear, a wide range of results may be found (due to the statistical errors depending on counting rate level, relative wear increases, measuring time, etc.). Because of the error theory it is necessary to reach a suitable compromise between test conditions and the demanded accuracy of the obtained results. Road and laboratory tests showed how various parameters influence engine wear rate. The effect of different factors was studied (different oils, oil filtration, frequent oil changes, cooling-water temperature, etc.) and it was concluded that piston ring wear and especially bearing wear is caused mainly by rising engine-speed and load. The sensitivity of the radiotracer technique allows the detection of 0.001 mg of wear debris per cubic centimeter of oil filling; this is one of the main advantages of the method. The accuracy and reliability of results, however, is limited to a certain extent by the statistical nature of the traced phenomenon. For good measurement reproducibility, strict observance of all operating parameters is inevitable. Care must be taken to measure and compare the wear rate during the same period of engine life for each test. (auth)

14688 INVESTIGATION OF THE WHEEL-FLANGE LUBRICATION OF RAILWAY TRAINS. Donhoffer, D. K.; Duftschmid, K. E. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). pp 101-8 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

A tracer method was applied to investigate the wheel-flange lubrication action of the new Austrian multiple-unit train "Transalpin." On electric engines the flanges of the first pair of wheels are lubricated by a pendulum oil pump. This pump starts to work when there is lateral movement of the engine on curves or at high speed on straight lines. The lubricating oil is transferred, while the train is underway, from the first wheel to the inner surface of the rail. From there it should be taken up by the following wheels of the train. In this way the friction between the rails and the wheel flanges can be reduced and as a consequence the wear of material is decreased. Until the present investigation it has not been possible to get quantitative information about the action of this type of lubrication. By adding the tracer ^{198}Au in the form of a colloid to the lubricating oil (specific activity 0.5 Ci/l), quantitative measurements of the oil transport mechanism could be made on the moving train. The detection of the labelled lubricant was possible even on the last wheels of a train of 44 axles. The oil films which were still detectable on the wheel flanges had a thickness of about 0.3 microns. By this tracer method, the dependence of lubrication on the speed and the line conditions can also be determined. The tracer method has a wide range of applications in the study of underway conditions in railroad operation including the investigation of the side movement of trains. (auth)

14689 REVIEW OF RADIOTRACER APPLICATIONS IN GEOPHYSICS IN THE UNITED STATES OF AMERICA. Mott, W. E.; Dempsey, J. C. (Atomic Energy Commission, Washington, D. C.). pp 111-30 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The geophysical applications of radiotracers in the United States have grown steadily in number, scope, and importance since the radioactive mineral carnotite was first used in oil-well cementing operations nearly thirty years ago. Results of laboratory and field investigations with radiotracers have led to realization and elucidation of underground conditions and events in petroleum production that would not otherwise have been possible. And still today, in cases where there are competing methods of obtaining information or performing an operation, the tracer approach often offers greater accuracy, more positive data, better operational control, or greater savings in time or money. Radiotracers are extensively used in the drilling, completion, and treatment of oil wells and in secondary recovery operations. They have proved particularly effective for following the movements of fluids in, adjacent to, and between wellbores and for following and pinpointing the stopping-place of materials introduced into wellbores. Specific applications include: the determination of production profiles; the determination of injectivity profiles and the rate and path of travel between injection and production wells; the location of cement tops; thief zones, channels, and casing leaks; the control of the placement of plugging materials; and, the determination of the number, type, and extent of fractures following stimulation. The application of radiotracers to geophysical problems in the USA is reviewed. An aim is to evaluate the present position of the radiotracer technique with emphasis on extent of use, practical limitations, and competition from alternative techniques. (auth)

14690 RADIOACTIVE TRACERS IN GEOPHYSICS. Alekseev, F. A.; Srebrodolskii, D. M. (All-Union Scientific Research Inst. for Nuclear Geophysics and Geochemistry, Moscow). pp 133-48 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Radioactive tracers are widely used in geophysics for solving various problems of the oil industry. The main applications are: in injection wells, determining water formations and checking conditions in casings; in producing wells, determining annular circulation and checking casing conditions; and determining the level of the cement top when deep wells are encased in concrete, especially in regions of elevated temperature. To solve these problems use is made of the isotopes ^{59}Fe, ^{95}Zr, ^{65}Zn and ^{131}I, in doses ranging from 0.5 to 1 mCi per m^3 of solution. The following will give some idea of the scope of the investigations being carried on with radioactive tracers. At the Romashkinsky deposit in the Tatar Autonomous SSR, a total of 220 wells was investigated in 1965 with a view to resolving the problems listed above. Of these, 150 were injection wells and 70 producer wells. In the oil deposits of Western Turkmenistan, 132 wells were investigated with radioactive tracers in 1965. In recent years there has been a considerable reduction in the work involved in detecting zones of hydraulic fracturing, determining cement ring thickness in the cementing of wells and delimiting the oil-bearing beds and water formations in a layer. This is due to the successful solution of these problems by other methods (radial cement thickness indicators, INM etc.) and the achievement of safe methods of work. Of late, increasing use is being made of tritium as a tracer, e.g., in determining the rate of water movement in a layer during the working of deposits, in techniques for pressure maintenance of fields, and in solving problems relating to the hydrodynamic relationships between individual layers and productive zones in massive oil fields. These problems are being solved by methods based on the use of radioactive tracers in aqueous form. Natural tritium is beginning to be used in solving problems relating to the extent of surface water infiltration and flooding in mine workings. The technological questions arising in the use of these methods, the problems which have been solved, and the economic advantages are discussed. (auth)

14691 AUTORADIOGRAPHY IN STUDYING THE ALTERATION OF ROCKS. Leveque, P.; Vigneaux, M. (Univ., Bordeaux). pp 151-7 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

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The alteration of rocks intended for use as the foundations of large-scale civil engineering projects, for building construction and for rock piling has been studied and numerous tests carried out; some of these tests have been standardized in varying degrees. The conventional method of autoradiography has been used to develop one of the processes for estimating alteration due, in particular, to thermal shocks. The progressive alteration of different rocks in the form of microfissurations was followed by using ^{35}S and ^{32}P. This process is considerably more accurate than that based solely on utilization of the characteristics of rocks in normal or polarized light. In addition, it permits absolute comparison of the initial microfissuration conditions of the sample and the microfissuration found after an increasing number of thermal shock cycles. The results of the process are given. (auth)

14692 STUDY OF AN OIL FIELD (HASSI MESSAOUD) BY INJECTION OF TRITIATED METHANE, ETHANE, PROPANE, AND BUTANE. Gondouin, M. (Geopetrole, Paris); Comier, J. J.; Thibierge, P.; Repal, S. N. pp 161-75 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Gas is injected into a deposit to increase the yield of oil contained in the rock and to maintain the pressure of the fluids at a value sufficient for the wells to remain naturally eruptive. The efficiency of this technique depends mainly on establishing a uniform displacement front in spite of heterogeneities. When the gas is injected simultaneously into several wells, the gas-oil displacement can be checked only if the origin of the gas reaching the producer wells is known with certainty. This is achieved by mixing with the gas from each of the injection wells a radioactive tracer whose path in the oil-bearing rock faithfully reproduces the movement of the gas-oil front. The tracers used are tritiated methane, ethane, propane and butane, which are injected respectively into four wells in amounts of up to 200 Ci. The distance separating each injection well from a producer well is considerable (1 to 6 km) and the oil volume is great, so that the radioactive tracer undergoes very marked dilution during its displacement. For industrial-scale detection of the arrival of the different tracers at the producers, it is therefore necessary to use very sensitive methods. Samples of oil are taken at the head of the producers at a pressure of approx. 50 kg/cm^2. The gas in solution in the oil is separated into four fractions, which are respectively rich in C_1, C_2, C_3, and C_4 with a degree of purity better than 90%. The beta radiation of each of the fractions is then measured using a double-envelope proportional counter placed in a lead container and connected to an anti-coincidence counting system. The long-term possibility of isotopic exchange between the different tracers and the hydrocarbons present in the rock were studied experimentally under the conditions of pressure and temperature at the deposit. (auth)

14693 USE OF NATURALLY OCCURRING RADIOISOTOPES FOR CHECKING DAMS IN THE BESKID RANGE. Iirkovskii, R. (Ostrava Mining Inst., Czechoslovakia). pp 177-85 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Potentially dangerous faults, fissures, or other rock contacts in the areas of Sance-Recice and between Dolni Becva and Rosnov in which dams are being constructed are discussed. Radon was used in the investigation since it is a radioactive element occurring naturally in the soil and in the geological faults in this area. Soundings were made to detect radioactivity. Disturbances which cut across the axis of the Ostravice River were discovered in the Sance-Recice area. The foundations of the dam in Dolni Becva were not disturbed. (auth)

14694 RECENT DEVELOPMENTS IN THE USE OF RADIOACTIVE TRACERS IN THE ROMANIAN OIL INDUSTRY. Comanescu, V. (Institut de Physique Atomique, Bucharest); Sandru, P.; Topa, A.; Peteu, Gh. pp 187-204 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Recent work with tracers has been concerned with the use of stable tracers having special nuclear properties which enable them to be detected under industrial conditions, and also with the simultaneous use of several tracers. The industrial-scale use of cadmium as a tracer in oil pipelines is described. To eliminate the handling of open radioactive sources, a labelling method was developed involving the use of a nonradioactive substance containing an isotope with a large cross-section for thermal neutron reactions, which they irradiate with a neutron source. For this purpose they use natural cadmium, in the form of $CdSO_4$. The experiments were performed in the laboratory, on sections of industrial-type pipe, in different geometries and with different concentrations of $CdSO_4$. The counting rates for thermal neutrons were measured with a BF_3 counter and for capture gamma rays with a scintillation counter. The sensitivity threshold was determined. The results are presented in the form of graphs and discussed. Using cadmium naphthenate, experiments in situ were performed. A multiple tracer study of the procedure for water injection in oil wells was made. The principle of the method consists of injecting water into injection wells so as to promote secondary recovery of oil and improve oil yield. Water movement through the layers of the injection wells (located at the corners of a zone in the shape of a square) to the reaction well was monitored by the simultaneous use of ^{131}I, ^{65}Zn and D_2O (which were selectively detected) and with the help of filtration devices for retaining the radionuclides. The results obtained show that the water has a tendency to become channeled. These results are in agreement with the water mineralization measurements in the reaction wells. The procedure described can also be extended to other branches of industry. (auth)

14695 TRACER INVESTIGATIONS OF EFFLUENT DISPERSION. Harremoes, P. (Danish Isotope Centre, Copenhagen). pp 207-17 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The technique for tracings in the sea has been refined and today such investigations are routinely performed before selection of the site for future sewage disposal from industries and municipalities. In Denmark this development has had a considerable impact on the general policy of marine disposal. Routine investigations are based on tracing an abruptly discharged tracer solution at the proposed site for sewage disposal. Approximately 1 Ci of ^{82}Br as ammonium bromide is used. The movement and dispersion of the tracer is recorded by sailing a boat in and out of the cloud of radioactivity. Time, location and the concentration of radioactivity at the surface is recorded on a 16-mm film every 20 sec. From these data the dispersion of effluent, which is continuously discharged at the site, can be calculated by integration with respect to time. Such tracings are made for typical weather and current conditions to reach a statistical prediction of pollution, which can be compared with a permissible pollution. Tracer injections at different sites permit a selection of the most economical site and of the required purification of the sewage, i.e., below the limits for bathing-water pollution. During seven years, about 130 injections have been made and so far this material has been treated with respect to the questions posed by the customer only. However, this valuable material gives an opportunity for comparison with an abundance of theories on turbulent diffusion in the sea. During 1965 a technique for submerged tracings was developed. This technique is important in water where the sewage may be trapped in density stratifications at the site for disposal. An investigation in the northern part of the Sound between Denmark and Sweden was performed during 1965 in collaboration with the Isotope Techniques Laboratory, Stockholm. Continuous discharge of labelled sewage through a temporary outlet at a depth of 13 m was used. Dispersion near the outlet was measured from an anchored boat. Tracing of the trapped sewage was performed by dragging detectors at four different levels through the submerged sewage field while the results were recorded every 10 sec by photographic means. The establishment of submerged sewage fields may enable the municipality to save secondary treatment of the sewage and still be within the standards of pollution. (auth)

14696 USE OF RADIOACTIVE TRACERS IN STUDYING THE DISPERSION OF CONTAMINATING ELEMENTS IN THE SEA, IN RIVERS, AND IN LAKES. Guizerix, J. (Centre d'Etudes Nucleaires, Grenoble, France); Molinari, J.; Gaillard, B.; Aubert, M. pp 221-36 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Applications of radioactive tracers in pollution studies are considered. Studies of dispersion of contaminated water from an existing or a future point of disposal by means of continuous or point injection techniques are described. The problem of linearity of the system is also considered. Special attention

is paid to the results of a critical comparative study of colored tracers of the rhodamine type and radioactive tracers. (auth)

14697 APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO STACK-GAS TRACING. Nakasa, H.; Ohno, H. (Central Research Inst. of Electric Power Industry, Tokyo). pp 239-48 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Air pollution by sulphur dioxide has recently become a serious problem to industrial areas where there are many contaminating sources, both industrial and domestic. It is necessary to trace the effluent gas from a particular stack in order to estimate quantitatively its proportionate share of the total resulting intensity of air pollution. In tracing stack gas from a steam power station over a distance of more than 10 km, tracer concentrations at sampling points become extremely dilute by diffusion in the atmosphere. Then, a special analysing technique is needed which is capable of detecting tracer substances less than 1 ppB quantitatively. Neutron activation analysis was applied to a stack-gas tracer technique using cobalt sulphate. Cobalt was selected among such easily activated elements as Na, Cl, Mn, In, Sb and others for the following reasons: relatively large activation cross-section; energetic and easily detected gamma-ray emission. ^{60}Co can be detected quantitatively from 2.50 MeV sum-peak without chemical separation after cooling the irradiated samples; insignificant concentration in the atmosphere; nontoxicity; and ready adaptability to field working conditions. Dispersal of the cobalt sulphate was carried out by spraying its solution into a stack-gas stream, using an atomizer and high-pressure air. Cobalt sulphate particles, which dried in the stack and were emitted with gas into the atmosphere, were caught on a filter paper of the sampler with floating dust. Collected samples were irradiated in a thermal neutron flux of 1.7×10^{12} n/cm^2 sec in the HTR reactor for 15 hr. The radioactivity was measured by means of a multi-channel pulse height analyser after cooling for three weeks. This method permits the determination of cobalt in amounts of 5×10^{-8} g with an accuracy of 10%. Field tests have shown that this tracer technique is a useful tool in the observation of the stack-gas diffusion properties in industrial areas. (auth)

14698 RADIOMETRIC DETERMINATION OF MOISTURE IN GASES. Houtman, J. P. W.; Medema, J. (Reactor Instituut, Delft, Netherlands). pp 261-70 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

It has been suggested that the water content of gases can be measured by means of a reaction with ^{14}C-labelled carbides and by counting the exit gas stream for ^{14}C-labelled acetylene. However, the ratio between water present in the feed and C_2H_2 in the exit gas was not found to be constant as a result of the presence of impurities and because of inter-conversion between CaO and $Ca(OH)_2$. Studies were directed primarily to the influence of reaction conditions on these effects. Reaction rates of a few carbides and their mixtures were compared. Part of this work has been carried out with inactive carbides and gas chromatography for the analyses. Finally, tracered carbides were used in combination with an end-window G-M detector. By a proper selection of temperature (50°C) and gas flow it appeared to be possible to achieve a constant count-rate response relative to the amount of moisture in the feed. When using a carbide mixture with a specific activity of 6 mCi/g, a moisture content as low as 1 to 10 ppM can be measured. The instrument can easily be built for continuous registration. (auth)

14699 PRODUCTION OF SHORT-LIVED RADIOISOTOPE TRACERS WITH AN Sb:Be SOURCE. Churchill, T. R. (Atomic Energy of Canada Ltd., Ottawa). pp 271-87 of Radioisotope Tracers in Industryand Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

More than half the radioisotopes of potential interest for tracer studies have half-lives of less than a few days. Most of these short-lived radioisotopes are little used because of the cost and practical difficulties in procuring them. An Sb:Be photoneutron source can provide a flux density of 10^9 n/cm^2 sec through a volume which can approach 1000 cm^3 and in a facility which is sufficiently compact and light in weight to be easily transported in a truck. Either thermal or fast neutrons can be produced as required. With such a source for their production, usable quantities of radioisotopes with half-lives as short as one second can be provided right at the site of the tracer study. A list of tracers suitable for production by this method is presented, together with suggested applications and a comparison with alternate means of production. Operating experience with such a facility is described. (auth)

14700 USE OF AN IONIZATION CHAMBER AND TRITIATED OIL FOR CONTINUOUS MEASUREMENT OF THE OIL CONSUMPTION OF AN INTERNAL COMBUSTION ENGINE. Anguenot, F. (Centre d'Etudes Nucleaires, Saclay, France). pp 289-99 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

By adding tritiated squalene to the lubricating oil and passing some of the exhaust gases through an ionization chamber kept at 150°C to avoid water vapour condensation, it was possible to carry out continuous measurement of the oil consumption of an internal combustion engine. The sensitivity of the chamber is of the order of 0.015 μCi of tritiated water per liter of exhaust gas. The specific activities used were of the order of 0.3 Ci per liter of oil; this value is considerably higher than that used when measuring the samples by liquid scintillation, but this disadvantage is largely offset by the continuity of the measurements. Owing to the intense ionization of the exhaust gases, it was necessary to place an ion trap before the chamber. The method has been used on an engine test bench for two years and has now reached a stage suitable for practical development. By making further improvements, which have not yet been done, it seems likely that this method can be applied to a vehicle in normal operation. (auth)

14701 EVALUATION OF RESULTS FROM TRACER STUDIES ON PROCESS UNITS. Rotkirch, E.; Kommonen, F.; Castren, J. (EKONO, Association for Power and Fuel Economy, Helsinki). pp 349-69 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The radioactive tracer technique has long proved to be of value in industrial investigations and has a well-established position as a tool for research and design within the Finnish industry. Over the years the main interest has been to clarify material flow and mixing properties, and to map the behaviour of components of complex systems. Furthermore, radioactive tracers have been used in impartial acceptance testing of delivered industrial plants. As most of these applications nowadays are of a routine character, the test procedures involved are not described. Instead, the adapted data-handling system is described. For this purpose some case studies chosen from the cement industry as well as from the pulp and paper industry are discussed and illustrated by examples. In the process industry much interest has been devoted to predicting the influence of changes in process variables or in design criteria on the final product of the process studied. Therefore, mathematical models for various process units or process systems have been developed. The tracer technique represents in this respect an outstanding and even sometimes singular means of determining the structure of a process model and the value of the process parameters. The applications of these mathematical models have been possible and profitable due only to new developments in data handling. The described system of interpreting results makes it possible to use as fully as possible the information collected during the relatively short time interval of a tracer test, and also to extrapolate the results with respect to both time and change of parameter value. The practical preparations of a test run are described. Thorough preparations are of decided importance for obtaining good results and full benefits from the efforts during any industrial investigation. (auth)

14702 DYNAMICS OF A CELLULOSE BLEACHING PLANT. Mannisto, H.; Niemi, A. (Univ. of Oulu, Finland). pp 371-83 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

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Tracer experiments were made in the bleaching plant of a sulphate cellulose factory to determine flow patterns for the cellulose fibers and, later, dynamic models in time and frequency domains for the process and for its parts. Activated glass fibers were used as the tracer compound. The representativeness and the radiation properties of the material used were analysed before the experiments. The tracer batches were fed as instantaneous impulses and the resulting activities of the pulp were measured continuously at several points along the line. The time integrals of the records, corrected for the radioactive

decay, were normalized to obtain the residence-time distribution functions. Computer methods were developed for the above calculations and for the calculations described below. The programs were prepared in the ALGOL programming language. The frequency characteristics for the parts of the process between the feed point and the measuring points were determined from the activity values at even time intervals by means of a Fourier transformation. The characteristics for individual process units were subsequently obtained from these. At the same time a program was developed for straightforward computation of the frequency characteristics of a process with finite pulses as input and output variables. To obtain a good high-frequency resolution the methods of integration, appropriate for rapidly oscillating functions, were studied; of these, Filon's method was chosen to be used. Possibilities for the determination of the weighting function of a process unit by computer methods through the inverse Fourier transformation and by means of the convolution integral in the time domain are discussed. Also some analytic functions were used to approximate the measured values, viz. transfer functions of low order with a delay term, the corresponding time domain expressions and the diffusion model. The values of the parameters were determined by the method of least squares in both the time and frequency domains. The effective volumes of the process vessels and the attenuation in the bleaching plant of disturbances due to the batchwise cooking are discussed. (auth)

14703 EVALUATION OF TRACER INVESTIGATIONS ON FLOW IN SYSTEMS WITH RECIRCULATION. Ljunggren, K. (Isotope Techniques Lab., Stockholm). pp 385-91 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Radioactive tracers are of considerable importance in investigations of the essential features of the flow in industrial process vessels. The technique, in which tracer is added to the inlet of the system and the resulting concentration-vs.-time relationship is recorded at the outlet, has been experimentally established and yields information in terms of mean residence time, dispersion, etc. In systems with recirculation, where some of the tracer after having been recorded at the outlet is again fed back to the inlet, a simple evaluation of the concentration-vs.-time curve is not possible since the contributions from the recycling tracer cannot, as a rule, be separated from the curve representing the first passage of tracer. Assuming that only part of the tracer is fed back on each return and that the system is in steady-state operation, a simple set of relationships have been derived which permit calculation of the recirculating fraction of the flow as well as of the mean and variance of the residence-time distribution corresponding to a momentary addition of tracer at the inlet (i.e., the transfer function of the system) from parameters taken from the composite concentration curve recorded at the exit. The methods developed have been applied in the evaluation of a number of tracer investigations on liquor flow through the chip bed in a continuous digester for pulp making. A complete analysis of the experimental data could be made to give consistent results. (auth)

14704 SOME EXAMPLES OF RESIDENCE-TIME DISTRIBUTION STUDIES IN LARGE-SCALE CHEMICAL PROCESSES BY USING RADIOTRACER TECHNIQUES. Bullock, R. M.; Johnson, P.; Whiston, J. (Imperial Chemical Industries Ltd., Billingham, Eng.). pp 393-406 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The application of radiotracers to determine flow patterns in chemical processes is discussed with particular reference to the derivation of design data from model reactors for translation to large-scale units, the study of operating efficiency and design attainment in established plant and the rapid identification of various types of process malfunction. The requirements governing the selection of tracers for various types of media are considered and an example is given of the testing of the behaviour of a typical tracer before use in a particular large-scale process operating at 250 atm and 200°C. Information which may be derived from flow patterns is discussed including the determination of mixing parameters, gas hold-up in gas/liquid reactions and the detection of channelling and stagnant regions. Practical results and their interpretation are given in relation to an olefine hydroformylation reaction system, a process for the conversion of propylene to isopropanol, a moving bed catalyst system for the isomerization of xylenes and a three-stage gas-liquid reaction system. The use of mean residence-time data for the detection of leakage between reaction vessels and a heat interchanger system is given as an example of the identification of process malfunction. (auth)

14705 RADIOACTIVE TRACER APPLICATIONS IN THE STUDY OF CONTINUOUSLY WORKING BATTERIES IN ALUMINA PRODUCTION. Bujdoso, E. (Research Inst. for Non-Ferrous Metals, Budapest). pp 409-15 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The greater part of continuously working equipment used in alumina production may be considered as containers in series. Their number, volume and the flow rate of material are determined by the time taken to carry out a certain chemical reaction. The theoretical laws of material flow especially for containers in series are described. The most characteristic data, such as mean residence time, hold-back, blocked volume, etc., may easily be determined experimentally by means of radioactive tracers. The comparison of measured and calculated data indicates the imperfections of the system and helps to correct them. The above-mentioned statements are verified by examples in which the tracer method is used in several batteries of autoclaves for continuous digestion and in a precipitator series for decomposition of aluminum hydroxide in alumina plants using the Bayer method. (auth)

14706 STUDY OF CHEMICAL PROCESSES BY ISOTOPE TRACER TECHNIQUES. Kulcsar, M. (Research Inst. of Heavy Chemical Industries, Veszprem, Hungary). pp 417-26 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The flow of material was studied on a large scale in the laboratory, in a film reactor of novel type, and in a gas-liquid contactor with perforated plates, and also in industrial equipment namely, in the mixer of a continuous superphosphate plant and in an oven for the manufacture of calcium carbide. The novel type of film reactor is characterized by a rotor carrying four cylinders rolling on the inner surface of the cylindrical body of the film reactor. When the rotor revolves, the cylinders are pressed against the internal surface of the body and are compelled to rotate so that the liquid, introduced at the top of the apparatus, forms a film between the inner surface of the body and the outer surface of the rolling cylinders. In the reactor with perforated plates, developed for the continuous contacting of liquid-phase paraphenetidine and acetone vapour, the flow of the liquid was studied with ^{32}P tracer and that of the iodine (used as catalyst) with ^{131}I. In the Moritz–Standaert continuous superphosphate plant, flow and mixing conditions (established by varying the feed rate and the operation of the mixing apparatus) were studied by an isotope tracer technique. On the basis of experimental results, the residence time of the pulp flowing through the apparatus could be increased, resulting in an improvement in the quality of the product, and consequently in the economics. Similarly, the flow of raw material through an electric carbide oven was studied with the aid of the isotope ^{32}P. Experimental results prompted on the one hand the modification of the oven, and on the other hand that of the operational conditions, and are expected to result in increased productivity. (auth)

14707 INDUSTRIAL USES OF ACTIVABLE TRACERS IN METALLURGY, GLASSMAKING, AND CHEMISTRY. Bondy, Ch.; Robin, G.; Vidal, J. P. (Societe l'Atome Industriel, Chatillon-sous-Bagneux, France). pp 429-42 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

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There are many possible industrial applications for the method of activable tracers in which a chemical tracer is identified and measured by neutron activation. All experiments with activable tracers involve the following steps: analysis of blank samples, choice of tracer element, choice of the chemical and physical method of introducing the tracer, product labelling, sampling, activation analysis, and interpretation of results. These steps are discussed; special attention is paid to the question of practical sensitivity of analysis in a complex matrix and to the problem of stability of extreme tracer dilutions. Tables are given for the choice of tracers. Various industrial applications have been tried: labelling of lubrication oils for subsequent identification; study of bubble transport in distillation columns; study of the distribution of residence times for materials in a glass-making furnace (this experiment was carried out simultaneously using activable and radioactive tracers); study of the distribution

of a textile oil on a textile thread; study of refractory wear in an oxygen convertor in a steelworks; and measurement of the displacement time of products in an oil refinery unit. For each of these applications the general principles are described, the question of tracer choice is discussed and the results obtained are given. The method is of interest because of the range of problems that can be studied and the easy application of the process under industrial conditions. (auth)

14708 MOVEMENT OF A CAPROLACTUM POLYMERIZATION MIXTURE THROUGH CONTINUOUS-ACTION POLYMERIZATION EQUIPMENT OF THE "Z-TUBE" TYPE. Hoffman, P. (Institut de Recherches Nucleaires, Warsaw); Gawlowska, W.; Cieslik, S.; Winnicki, R.; Poczynajlo, A.; Zaluska, R.; Rybicki, Z.; Wilczynski, S.; Plonka, Z.; Klimek, W. pp. 451-87 of Radioisotope Tracers in Industry and Geophysis. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

One of the industrial methods of hydrolytic polymerization of caprolactum which is the low-pressure continuous method in "Z-tube" polymerization equipment is described. During the movement period in the polymerization equipment the viscosity of the mixture increases from 5 P at the beginning of the path travelled to 1000 P at the end. There is also an increase in viscosity from the walls towards the center of the tube. This variation of viscosity in the continuously moving polymerization mixture means that different parts of it are retained in the equipment for very different lengths of time, so that the end product is a mixture of macromolecules of different molecular weights. To obtain a product consisting of molecules of approximately equal molecular weight, it is necessary to ensure that the whole of the polymerization mixture remains in the equipment for the same length of time. For this purpose obstacles are placed in the path of the moving mixture, in order to slow the movement of the liquid in the central path of the tube, thus levelling out the rate of flow. To test the efficiency of the various obstacles and also of other technical improvements, a small amount of caprolactum labelled with ^{82}Br or ^{24}Na was introduced. From the results obtained the residence time of a portion of the product in the polymerization equipment can be determined for any desired interval, and also the amount of the mixture which, for given conditions, passes through the equipment during the time taken as optimum. With the proposed method, it is possible to determine the effect of various design features of Z-tube polymerization equipment on the duration and kinetics of movement of the caprolactum polymerization mixture. (auth)

14709 USE OF GERMANIUM ORGANIC COMPOUNDS LABELED WITH ^{77}Ge TO INVESTIGATE THE BEHAVIOR OF PETROLEUM PRODUCTS IN REFINING INSTALLATIONS. Akerman, K.; Zablotny, V.; Zablotna, R.; Shukhnik, A. (Inst. for Nuclear Research, Warsaw). pp 459-66 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The labeled organic compounds used to investigate the behaviour of petroleum products in refining equipment cannot always be used because their chemical and physical properties differ so markedly from those of the products. Comparison of the chemical, physical and radiochemical properties of the various types of labelled organic compound leads to the conclusion that the most suitable ones for isotope studies in the petroleum-refining industry are germanium-organic compounds labelled with ^{77}Ge, since they have chemical and physical properties very close to those of hydrocarbons, and their radiochemical characteristics are very suitable for industrial isotope investigations. Methods of synthesizing various germanium-organic compounds which are then subjected to neutron activation to produce the corresponding compounds labelled with ^{77}Ge were, therefore, developed. Germanium-organic compounds were subjected, in amounts of about 10 to 20 g, to activation in a neutron flux of 10^{13} n/cm^2 sec for 1 to 5 hr depending on the activity required for the investigations. The test on industrial equipment were normally carried out 12 to 15 hr after activation. The recording apparatus was placed at suitable points on the outer walls of the equipment. As the radioactive substances passed the measuring point the apparatus normally gave maximum readings exceeding the background by factors of several tens to several hundreds. Tetraethyl-germanium labelled with ^{77}Ge was used to determine the reflux circulation time and the time taken for the petroleum fraction to evaporate on the corresponding plates of a distillation column operating at normal pressure with a productivity of 400 tons per day. Tetra-n-amyl germanium labelled with ^{77}Ge was used to determine the linear rate of movement of petroleum in the separate sections of the oven used to heat it before feeding to the distillation column. The capacity of this oven was 400 tons per hour. These investigations made it possible to determine genuine technological indices, and also showed conclusively that germanium-organic compounds labelled with ^{77}Ge lend themselves very well to technological studies in petroleum refining. Good results have been obtained and work is being continued to investigate the processes occurring in the separate units of the refining equipment. (auth)

14710 PROCESS ANALYSIS IN A CHEMICAL PLANT BY MEANS OF RADIOACTIVE TRACERS. Hirayama, T.; Hamada, K.; Osada, K. (Showa Denko K. K., Tokyo). pp 469-76 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Following the movement of solids and fluids is important in chemical processes to determine mixing efficiency and residence time. Since it is necessary to follow many complex substances such as raw materials, intermediates and reactants in plant investigations, it is often necessary to ascertain whether the behaviour of the radioisotope tracer and the substance to be traced are identical. The most difficult problem is to determine the best method of labelling, a factor which is a substantial key to the success of an experiment. Usually, there are three labelling techniques: radioisotope labelling, pre-activation of the material and post-activation of the material. Practical examples of the double-tracer technique, a combination of conventional radioisotope labelling and post-activation methods by means of activation analysis is described. In process analysis by means of tracers, a practical measurement method should also be devised and developed for each experiment. Phosphorus-32 and gold (non-radioactive) were used to measure retention time in a carbon-black plant. The radioisotope was pumped into a feedstock pipe positioned before the reactor and samples were taken from each process of the plant, including the bag filter, mixer and product tank. After sampling from each step of the process, ^{32}P in a semi-infinite powder sample was measured in situ by beta counting, and the gold was measured by gamma counting after activating the sample in a reactor. The experiment showed that both tracers had the same residence time, which was shorter than expected. Useful data were also obtained from the dispersion pattern of the material flow for future operation controls, including the time required to change from one grade of product to another. Practical tracer techniques to measure mixing characteristics in high-speed gas flows using ^{85}Kr have been developed. A study of the measurement method was conducted by calculating the differential values of activity changes from records of changes of a digital counter and a timer which were continuously and photographically recorded, in spite of the fact that the residence time was only several seconds. The diffusion constant was then obtained from the concentration-time curve. (auth)

14711 RADIOACTIVE TRACER STUDIES OF INDUSTRIAL PROCESSES FOR THE ELECTROLYTIC REFINING OF ALUMINIUM AND THE SILICOTHERMIC PRODUCTION OF MAGNESIUM. Akerman, K.; Brafman, M.; Biala, Nelli; Kierzek, J.; Kozminska, Danuta; Tabor, W. (Institut de Recherches Nucleaires, Warsaw. Usines Metallurgiques Trzebinia, Poland). pp 479-502 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The possibility of producing 99.999% pure aluminum by double electrolytic refining and of increasing the purity of silicothermic magnesium by modifying the conditions under which the calcined dolomite is reduced and the vapours liberated are condensed is considered. Applying the method based on three melted layers, a study was made of the industrial-scale electrolytic refining of aluminum, using the radioisotopes ^{59}Fe, ^{64}Cu, ^{69m}Zn, ^{72}Ga, ^{114}In, ^{115}Cd and ^{198}Au from its impurities. By adding ^{24}Na-labelled cryolite to the electrolyte, the part played by that element in the mechanism by which current is transferred to the cathode and to the anode was determined. The interpretation of the results is based on the theory of the formation of polyionic combinations and complexes and their effect on the mobility of ions of different impurities during the electrolysis of the melted salts. In the case of magnesium, the mechanism of materials passage in rotating dolomite calcination furnaces and also the processes of thermal reduction of calcined dolomite and of the condensation of vapours from impurities in the vacuum furnace used for the production of silicothermic magnesium were studied. In this work they used dolomite activated in a reactor (to obtain radioactive sodium by activation of its impurity, sodium

carbonate); also, labelled oxides of zinc and copper and labelled sodium carbonate. (auth)

14712 MEASUREMENT OF CIRCULATION, RETENTION TIMES, AND FLOW PATTERNS IN AN ELECTROLYTIC REFINERY BY USING RADIOACTIVE TRACERS. Kato, M.; Sato, O.; Inoue, T. (Tokyo Univ.). pp 503-11 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Full-scale plant studies in a nickel electrolytic refinery by use of radioactive tracers are described. The method is particularly suitable since the flow of materials has to be kept to that pertaining under normal conditions. After considering the properties of the electrolyte, the sensitivity of detection, the possible contamination of the factory and other factors, ^{24}Na and ^{82}Br (with activities of 5 or 6 mCi each) were chosen as the tracers. The tracer was measured in situ by a dip-counting method using a water-cooled scintillation probe, a survey meter placed on the outer surface of a pipe junction and a well-type scintillation counter in the laboratory. The first experiment was to measure the circulation time through the electrolytic process by means of the peak-to-peak method. The resulting time, seven hours, was unexpectedly short in comparison with calculations. The second experiment was concerned with electrolyte flowing through two purifying vessels, each with a different construction. The same mixer was used for both vessels, each with outlets at the top. The inlets were on the opposite side, in one case at the top and in the other at the bottom. The experiment showed that the difference in the residence times was remarkably large. The third experiment was carried out in a series of electrolytic cells. Labelled electrolyte was continuously injected into a cathode chamber and 20- to 30-ml samples were periodically taken at nine different points by means of a special sampler. As a result, the flow patterns of the electrolyte were determined and the rapid mixing within the chamber was observed. Further, the flow rate of the electrolyte into the chamber was calculated by the continuous dilution method. (auth)

14713 RADIOTRACERS IN SWEDISH STEEL INDUSTRY. Eriksson, I. (Isotope Techniques Lab., Stockholm); Erwall, L. G.; Nyquist, O. pp 513-25 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Recent tracer investigations in Swedish steel plants have mainly dealt with problems concerning non-metallic inclusions, slag weight determination and labelling of special steel qualities for identification. Suspected inclusion sources, such as furnace slag, ladle-bottom mortar and some brick materials as stopper, nozzle and channel bricks have been labelled radioactively in different ways. The labelling technique has been studied for the different systems and a new method was developed for brick materials. This includes vacuum impregnation with an aqueous solution of the inactive tracer, reheating to 1300°C and neutron-irradiation in a reactor. A sufficiently homogeneous labelling of the material was obtained in this way. The tracer used was terbium, which was added as the nitrate and then decomposed to oxide during the heating process. The oxide is strongly bound to the ceramic material. The number of radioactive inclusions was determined by autoradiography, and related to the total number of inclusions, obtained by visual slag-counting, to give the percentage of inclusions originating from the labelled object. Investigations were made using simultaneous labelling with one short-lived e.g., ^{140}La and one long-lived e.g., ^{160}Tb radioisotope. The slag weight determinations were made using the isotope dilution technique with ^{131}Ba and ^{140}La as tracers. A difference in slag weight was sometimes obtained. An attempt was made to explain these deviations. The material transport through a blast furnace was followed using a piece of graphite, labelled with $^{140}La_2O_3$, and measuring the radiation intensity outside the furnace walls and in the tuyere. Studies were made to determine suitable radiotracers for labelling of steel for subsequent identification. Up to three different isotopes can be used simultaneously without making the identification too complicated for practical use. (auth)

14714 USE OF OPEN SOURCES FOR MEASURING THE RETENTION TIME OF MATERIALS ON PRODUCTION LINES. Kubin, M. (Inst. of Research, Production, and Use of Radioisotopes, Prague). pp 529-36 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

A method is described for the instantaneous introduction of a radioactive tracer at the input end of a flow under study and subsequent determination of the distribution of the activity in time, at the output end. The form of the curve depends on the parameters of the installation and its mode of operation. The curve can be analysed to establish, for example, the average time that a given material remains in the installation. Liquid-phase investigations were carried out on laboratory models of chemical vessels, using scintillation detectors and a screened probe. The experience gained has been used, for example, to investigate the industrial extraction of aqueous phenol using butyl acetate. ^{131}I in the form of water-soluble salt was used to determine how long the aqueous phase is retained in various sections of the column, the investigation being carried out in the course of actual production, without interrupting the flow. A discussion on analysis of the curves and on the isotopes and apparatus used is included. (auth)

14715 RESIDENCE-TIME DISTRIBUTIONS IN LAMINAR FLOWS AND DURING THE PASSAGE OF GRANULAR SOLIDS THROUGH ROTARY KILNS. Beek, W. J. (Technische Hogeschool, Delft, Netherlands); de Ridder, H. J.; Houtman, J. P. W.; Kuiper, D. pp 537-48 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Data on residence-time distributions are important in the design of apparatus for the chemical industry. Radioactive tracers can be useful in many cases, e.g., where a pulse technique is desired. Two examples are given in which a pulse of radioactive tracer is used. The first example deals with the residence-time distribution of a laminar, Newtonian flow in an annulus. This problem arises especially in the extrusion and injection molding of polymers and in the coating of wires with plastics. In these cases the fractions of polymer with long residence times may have other properties than the polymer that flows fastest, because the polymerization reaction or the degradation reactions go on during the process. Two difficulties are considered: the tracer pulse (a radioactive Au-sol suspended in the liquid used) cannot be distributed over the cross-section in proportion to the local flow velocity; and the outflowing liquid must be sampled discontinuously. Both effects have been studied and corrections are indicated. When these corrections are applied to the measured distribution curve, the result is in fair agreement with the calculated residence-time distribution. The second example considers the residence-time distribution in a granular solid (sand) passing through a rotary kiln. The response was measured at the outlet to a pulse at the inlet of radioactive material (sand impregnated with a solution of radioactive $AuCl_3$). When calculating the residence-time distribution from the experimental data, difficulties were encountered because the duration of the pulse was of the same order of magnitude as the average residence time. Considering this, it was found that the axial dispersion of the flow of sand could be described by an effective dispersion coefficient. This dispersion coefficient proved to be very low (order of magnitude 10^{-5} m^2/sec); hence, in practical situations, the flow of granular material through a rotary kiln may be considered as a plug flow, i.e., all the grains of sand have the same mean velocity. (auth)

14716 FLOW PATTERNS IN A CONTINUOUS GLASS-MAKING FURNACE. Balla, B.; Csetenyi, J. (National Atomic Energy Commission, Budapest). pp 551-61 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Investigations have been made with ^{51}Cr on the flow patterns in a glass-making furnace containing 720 tons of melt and operating continuously with six sheet-glass drawing machines. The radioactive tracer was injected rapidly through the left-side feeder-pocket of the furnace in the form of chromium oxide. The tracer was dissolved in the glass-melt and the path of this labelled melt was detected by sampling and subsequently measuring the activity of the samples. Sampling was performed on three opposite points of the left and right sides of the furnace respectively, partly from the melt, and partly from the edge of the product sheet every two hours throughout 24 days. However, samples were also taken at the left-side sampling points every quarter of an hour of the first three days. During the entire investigation, 2500 samples were tested. The specific activities of the samples in terms of time, i.e., the distribution of the residence-time of the isotope ^{51}Cr, well represent the flow of the melt for different sampling positions. From these functions an average flow rate of 0.16 to 0.19 m/hr can be calculated for the different parts of the furnace. The areas between the curves and the ab-

scissa which are proportional to the quantity of the tracer passing through the sampling points are not equal. Comparing these areas one can see that at 10 m from the feeder-pocket the flow rate is highest in the center of the tank. Fifty-six per cent of the melt flowing along the sides of the tank is from the material fed in on the same side whereas the other 44% is from that on the opposite side. At 24 m from the feeder-pocket the flow is uniform over the whole cross-section of the furnace and in the forked part (so-called forehearth) the flow rate depends on the ratio between the glass production of the left and right side machines. The descending and ascending branches of the curves of the distribution functions are described by equations which hold for back-mix flow-type reactors with both a rapid tracer injection and a continuous injection. This type of reactor provides the most advantageous mixing conditions for the transient materials. The intensive mixing and the consequent lengthened retention time of the melt is stimulated mainly by circulation effects. Two of these circulations have been discovered and investigated in detail, they were of 33 and 9.5 hr cycle-times respectively. (auth)

14717 ACCURACY AND PRECISION OF LIQUID FLOW MEASUREMENT BY RADIOACTIVE ISOTOPES. Clayton, C. G.; Spackman, R.; Ball, A. M. (Wantage Research Lab., Eng.). pp 563-84 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

One of the most important factors governing the general acceptance of flow measuring systems is the accuracy with which the methods can be applied. With radioactive isotopes, accuracy is limited, both by the nature of the hydraulic system and also by instrumental errors in the measuring equipment. In the limit, ultimate accuracy is determined by errors imposed by counting statistics. The origin and magnitude of the various types of error are discussed. An important error which may be introduced by the system arises from the need to restrict velocity and concentration measurements to the region where the tracer is completely mixed. A sufficiently long length of pipe to achieve mixing is not always available but methods of reducing the mixing distance to avoid the possibility of errors are discussed. Most important are the use of multiple injectors and high-speed jets, and the effect of using these techniques are described. Results illustrating the value of using a circulating pump to reduce mixing distance are also given. The magnitude of errors arising from the instruments and techniques used in the constant rate injection, continuous sample, total count and velocity methods are analysed. Expected results of overall accuracy for each of these techniques are compared with actual results in the flow range $5 \times 10^3 < Re < 5 \times 10^5$. It was shown that the best techniques can be consistently operated to an accuracy within ±0.2%. (auth)

14718 WATER FLOW MEASUREMENTS IN TURBINE EFFICIENCY DETERMINATIONS. Dahl, J. B.; Thomassen, J. (Kjeller Research Establishment, Norway). pp 591-6 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

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Radioactive tracer techniques based on the total count principle have been applied in a methodical study to develop an accurate and simple procedure for the determination of water flow in turbine efficiency measurements. Various tracer injection methods have been tested, and blasting of the container with the tracer in the water stream by means of explosives has proved most efficient. During the determination of the water flow, continuous sampling is carried out at the stream outlet by means of a precision double-membrane pump. Techniques for sample preparation and activity measurements are described together with a theory for the correction of errors due to different sample sizes caused by air bubbles etc. in the stream. The presented procedure has been used to investigate water flow in the range of 7-230 m^3/sec. An accuracy better than 1% has been achieved. (auth)

14719 TRACER STUDY OF FLOW CHARACTERISTICS IN A HIGH-SPEED GAS REACTION VESSEL BY MEANS OF ^{85}Kr. Berry, P. F. (Atomic Energy of Canada Ltd., Ottawa); Clayton, C. G.; Webb, J. W. pp 599-611 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

A study of the flow characteristics in a high-speed gas reaction vessel has been carried out using ^{85}Kr tracer gas, and the results are described. The practical difficulties encountered in an application of this kind ensue from the rapidity with which the concentration-time profile changes at the vessel outlet. Considerable distortion of the profile can occur due to the finite integration time of the detection unit, sampling rate and transients in the connecting pipe work. The effect of these factors on the interpretation of gas flow rate and residence-time distribution are discussed and the relative merits of a digital or analogue measurement of tracer concentration are compared. For the investigation, 6 mCi of ^{85}Kr were injected into the vessel by means of a high-speed injection system and the outgoing concentration was measured by sampling the gas through a plastic phosphor detector. The scintillation counter was operated in a dc mode, and a uv stripchart recorder was used to record the radiation intensity. Concentration profile corrective measures were applied and verified by changing the injection, sampling and detection conditions. The accuracy of the mean residence time determination was 5%. (auth)

14720 APPLICATION OF THE DILUTION PRINCIPLE TO THE MEASUREMENT OF GAS FLOW RATES IN LARGE-SCALE CHEMICAL PROCESSES. Johnson, P. (Imperial Chemical Industries Ltd., Billingham, Eng.). pp 615-23 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The value of radiotracer techniques is briefly discussed in relation to the accurate measurement of gaseous flow in continuous chemical processes with special reference to determinations which would be difficult by conventional instrumental methods. The application of the dilution principle to the measurement of particularly large rates is considered and a method involving an activity concentration technique is described in detail. In the method, carrier and ^{133}Xe are introduced into a gas cylinder which is pressurized with nitrogen. The tracer is injected at a constant accurately known rate into the gas stream to be measured. Samples taken from the stream are brought to equilibrium with known conditions of temperature and pressure and subjected to the concentration technique which involves circulation of the sample gas through a refrigerated trapping arrangement. Extraction of the active xenon from the gas sample is taken to completion by raising the partial pressure of xenon in the sample by the injection of inactive xenon at suitable intervals during the process. In this way a concentration factor of 10^3 is readily achieved and the small volume of ^{133}Xe and carrier resulting may be assayed under conditions of high efficiency. Flow rates in the region of 10^6 m^3/h can be measured with care to an accuracy of ±1%, using a total activity of approx. 100 mCi ^{133}Xe. Examples of the application of the dilution method — with and without the concentration technique — are discussed and the adaptation of the method to detect very small internal leakage rates between gas systems in chemical processes is described. (auth)

14721 USE OF RADIOACTIVE TRACERS FOR QUANTITATIVE DETERMINATION OF THE EFFICIENCY OF A MIXER. Guizerix, J. (Centre d'Etudes Nucleaires, Grenoble, France). pp 625-38 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

The response of a system, such as a continuous mixer, to an input stimulus represented by the sudden injection of a tracer at a single point, usually corresponds to the transfer function of that tracer and hence to the transfer function of the labelled phase. The conditions of application of this method are briefly discussed together with the conventional information it provides regarding mixing quality, dead volumes and by-pass rates. Mixers of all types are to be found, ranging from the "perfect" mixer to the "piston" mixer, whose transfer functions are exponential and gaussian, respectively. The following procedure is proposed to assign a quantitative value to the efficiency of a non-perfect mixer. The radioactive tracer is injected continuously at the system input; the variations in activity as a function of time are measured at the output. The output signal noise is analyzed and broken down into noise due to stochastic emission from the radiation, governed by a Poisson law, and noise due to the heterogeneity of the mixture. The relative mean-square deviation of the corresponding signal is taken as a measure of the efficiency of the mixer. (auth)

14722 USE OF RADIOISOTOPES TO DETERMINE MOLTEN METAL MIXER EFFICIENCY IN STEEL MAKING PRACTICE. Williams, K. F.; Howell, E. D. (The Steel Company of Wales Ltd., Port Talbot, Eng.). pp 641-50 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Molten iron transported from the blast furnace to the steel making plants is poured into reservoirs of about 1000 tons capacity and mixes with the iron already present. A need to determine the effectiveness of mixing during a period when the content of impurities in the molten iron was constant, led to the use of radiotracers. Radioactive iron powder was added to molten iron during casting at a blast furnace and then added to a mixer. Samples could be taken only when iron was poured from the mixer. The weight of iron in the mixer was known from records of iron added and subtracted, and the specific activity in the mixer for fully mixed conditions was calculated. By measuring the specific activities in samples taken from the mixer the state of mixing was determined. Further additions of unlabelled molten iron contributed to the investigations. New specific activities were calculated, and samples assayed for radioactive content. (auth)

14723 USE OF RADIOACTIVE TRACERS IN THE DEVELOPMENT OF NEW CHEMICAL PROCESSES. Whiston, J. (Imperial Chemical Industries Ltd., Billingham, Eng.). pp 651-66 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Radioactive tracers, principally ^{36}Cl, ^{35}S and ^{14}C, have been used to help solve a large number of exploratory (laboratory) and process development (semi-technical) problems arising in an industrial research laboratory. The uses of ^{14}C discussed include the determination of the relative rate of formic acid oxidation (in carboxylic acid mixtures) to carbon dioxide and the determination of the origin of carbon dioxide and a number of oxidative by-products in a hydrocarbon oxidation system. As an example of the use of Geiger-Mueller detectors and ^{36}Cl tracer, an investigation into the fate of chlorine added to an oxidation system is described. Determination of the partition coefficient of sulpholane in hydrocarbon-water mixtures and the measurement of the amount of sulpholane adsorbed onto a solid catalyst during the reaction of a hydrocarbon (containing small amounts of sulpholane) are described as typical uses of ^{35}S. Extensive use has been made of liquid scintillation counting and it has been found necessary to extend existing techniques and develop others, including the preparation and use of solid crystalline derivatives of aldehydes and organic acids, for the determination of specific activities of aldehydes and organic acids, for the dispersion of colored solids by ultra-sonic energy before counting in a thixotropic gel and for the accurate determination of the specific activity of carbon dioxide absorbed in solvents such as Hyamine. The full experimental procedures used are described, and the scope and limitations of these developments discussed. (auth)

14724 ORIGIN OF IMPURITIES AND HOW THEY GET INTO GALVANIC COATINGS. Mihics-Farkas, C.; Varga, K. (Csepel Iron and Metal Works, Hungary). pp 667-72 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

A critical investigation of the corrosion resistance of galvanic coatings is described. The investigations, which used radioisotope dilution analysis and tracer techniques, were aimed at studying the conditions under which impurities in the electrolyte are deposited in nickel layers during the electrolyte are deposited in nickel layers during the electrolytic process. The investigations were carried out in a nickel bath whose composition and operating conditions were as specified by the manufacturer. The amount of iron deposited in nickel coatings was determined when galvanizing at different voltages, the voltage limits being those available in the workshop. The amount of iron impurities in the bath was also varied and the local distribution of the iron deposited in the nickel coating was studied. Measurements were made to determine if the "brightening additive" in the bath and sodium fluotetraborate influenced the amount of iron deposited in the nickel coating. The extent of the influence of these impurities on the corrosion resistance of the nickel layer was studied. The corrosion resistance was investigated in the following media: 1:10 HCl solution at 24.8°C; 3% NaCl + 0.1% H_2O_2 solution at 24.8°C; and 100% damp space at 35 to 37°C. These studies showed that one of the most important impurities deposited in the nickel coating from the electrolytic bath which greatly influences the corrosion resistance is iron. Because of this, radioactive methods were used to investigate: the extent to which iron atoms from the iron used in the bath are dissolved during nickel plating; how these iron atoms are distributed in the bath; and how they are deposited during the electrolytic process, together with the nickel, on the same body from which they originated. The investigations were made under the following conditions: when the dissolving was done before the voltage was applied; when the voltage was gradually applied after the iron was introduced; when the iron was introduced into the bath at the electrolyzing voltage; and when copper-plated metal was dissolved. As a result, it was found that under certain circumstances in the electrolytic process, iron atoms are continuously dissolved from the object to be plated and these same atoms are deposited in the nickel layer during plating. (auth)

14725 USE OF RADIOACTIVE TRACERS FOR MEASURING THE DENSITY OF THE EMULSION (WATER-STEAM) FLOWING IN THE WATER-WALL TUBES OF INDUSTRIAL BOILERS. Blanc, D. (Univ., Toulouse); Cohen, H.; Maurel, B.; Maille, C.; Hossard, A. pp 673-89 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

Introduction of a radioactive nuclide into the water offers a rapid procedure for diagnosing the functioning and properties of industrial boilers without altering the phenomena to be measured. The choice of radionuclide must satisfy strict criteria; after a large number of trials, a mixture of ^{186}Re and ^{188}Re obtained by neutron irradiation of natural rhenium was chosen. The background noise is measured at the time of the trials with the help of a system of three tubes placed in front of the boiler, or of one tube placed in an inspection chamber. The density of the emulsion (water-steam) can be measured with an accuracy of between 10% and 15%. Trials were carried out on a boiler with a capacity of 3 tons of water operating under a pressure of 10 kg/cm^2 at 180°C. The emulsion density in several water-wall tubes was compared for different vapor flows, the density being measured along the whole length of the tube, which gives information on the thermal exchanges between the furnace and this tube. Trials will very soon be carried out on a power boiler belonging to Electricité de France (Creil Power Station). The personnel working around the boiler run no risk of irradiation since the quantities of radionuclide (10 to 25 μCi/liter of water) are small. The complete calculation of the isodose curves, verified by dosimetric measurements, shows that the dose 20 cm outside the boiler is below 90 mrads after 210 hr, which is 6 or 7 times lower than the maximum tolerable dose. The dose is even smaller in the case of a large boiler. (auth)

14726 SEPARATION OF THE ISOTOPIC HYDROGEN MOLECULES ON SYNTHETIC ZEOLITES OF A, X, AND Y TYPE IN VARIOUS FORMS. Gryasnova, Z. V.; Nikitin, O. T.; Andronikashvili, T. G.; Tsitsishvili, G. V.; Krupennikova, A. Yu. (Moscow State Univ. Inst. of Physical and Organic Chemistry, Tashkent). Isotopenpraxis, 3: 276-9(July 1967). (In Russian).

Synthetic zeolites of A, X, and Y types in the H, Na, Ni, Co, Ca, Cr, Mn forms have been studied for explaining the influences of the structure of the zeolite and the character of built-in ions on separation of isotopic molecules of hydrogen. A simple relationship between separation process of isotopic hydrogen molecules and the dimensions of the metal ion included in the zeolite structure has not been stated. The influence of zeolite properties as a function of silicon oxide-aluminum oxide ratio and the character of the ion included on the separation of isotopic molecules of hydrogen is shown. An exchange of H and D of the hydrogen included in the CrX zeolite structure has been observed. The results obtained show that in separating the isotopic molecules of hydrogen the essential role is played by the character of the cations and by the composition of the alumosilicate structure of the zeolite, i.e., the SiO_2-to-AlO_2 ratio. (auth)

14727 THICKNESS GAGING BY MEANS OF ^{85}Kr BREMSSTRAHLUNG AND ^{241}Am SOURCES WITH SPECIAL RESPECT TO ALUMINUM MATERIALS. Boehme, G. (VEB Vakutronik WIB, Dresden). Isotopenpraxis, 3: 262-5(July 1967). (In German).

Thickness gaging of Al materials using ^{85}Kr bremsstrahlung sources and ^{241}Am sources and heavy metal thickness measurements using ^{241}Am sources are discussed. The absorption curves, the relative physical sensitivities of measurement, and the measuring ranges of the Vakutronik thickness gage VA-T-75 resulting from them are presented. (auth)

14728 CONSUMPTION AND APPLICATION OF RADIOISOTOPES IN SPAIN IN 1965 AND 1966. PAPER OF THE JUNTA DE ENERGIA NUCLEAR. Dominguez, G.; Del Val Cob, M. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 389-402(July-Aug. 1967). (In Spanish).

The production and consumption of radioisotopes in Spain during 1965 and 1966 has expanded greatly over previous years as is shown by the tabulated information. The efforts of the JEN to encourage the industrial use of radioisotopes and to broaden the possible applications are outlined. (J.S.R.)

14729 ISOTOPIC ENERGY GENERATORS. Dominguez, G. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 341-62(July-Aug. 1967). (In Spanish).

The necessity for the development of new energy sources is briefly summarized. Radioactive decay as a energy source is discussed with respect to the quantitive aspects and the selection of the isotopic fuels. The criteria for the selection of isotopic fuels are tabulated. Conversion of the energy from radioactive decay by the use of isotopic batteries, thermal systems of direct conversion, and thermal systems of dynamic conversion are discussed in some detail. Specific fields where isotopic generators can be used are indicated. (J.S.R.)

14730 PRESENT STATE, FUTURE POSSIBILITIES, AND POTENTIAL ECONOMIC IMPACT OF THE PRESERVATION OF FOODS BY IRRADIATION ON A COMMERCIAL SCALE. Sune, N. Ortin (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 379-88(July-Aug. 1967). (In Spanish).

The results accumulated in various investigations in different countries on food preservation by irradiation are outlined with respect to the preservation of meat, poultry, eggs, grains, stored food products, fish, fruits, vegetables, greens, legumes, and potatoes, and onions. The steps made toward industrialization of radiopreservation of foods in the United States, Russia, Canada, and Spain are briefly outlined. The potential economic impact of food preservation by irradiation on a commercial scale is considered with respect to the food producers, food processing industry, packaging industry, irradiation sources and installations, refrigeration and storage facilities, transport industry, and the chemical industry. (J.S.R.)

14731 RADIOISOTOPES IN INDUSTRIAL CONTROL. Del Val Cob, M. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 11: 319-40(July-Aug. 1967). (In Spanish).

The economic aspects of the use of radioisotopes in industrial instrumentation are briefly discussed and illustrated by tabulation of the savings realized in various industries by the use of isotopic instrumentation. The principal characteristics of nucleonic instrumentation and the most important applications are described. The use of nucleonic instrumentations in Spanish industry is discussed and an evaluation is made of the savings. Present trends in nucleonic instrumentation in Spain and the world are briefly considered. (J.S.R.)

14732 RESEARCH ON ELIMINATION OF STATIC CHARGES BY THE USE OF RADIOISOTOPES. IV. ELIMINATION OF STATIC CHARGES IN OIL. Sakanushi, Katsuhiro. Sangyo Anzen Kenkyusho Hokoku, 15: 1-10(1967). (In Japanese).

Removal of static electricity from kerosene by means of radioisotopes was studied. $^{90}Sr-^{90}Y$ with a nominal intensity of 20 mCi was used as the β source, and the test oil was artificially charged with static electricity. The attenuation constant (α), involved in charge removal, was found to be dependent on the characteristic of the radioisotopes, the ambient experimental conditions, the method of irradiation, and the electric field (distribution) produced by the object material. In general, the mechanism of removal of the static electricity depended largely upon the intensity of the radioactive source, and not on the initial charge given to the oil. The effect of removal was similar to that for a charged powder. (NSA of Japan)

14733 ISOTOPE THERMAL THRUSTERS AND APPLICATION. Martinez, John S. (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). pp 87-154 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

Design studies and parametric mission analyses which have been performed during the past few years conclusively demonstrate that major savings can be effected in the cost of many future space missions through the timely development and application of radioisotope propulsion systems. Some of the advantages of radioisotope propulsion are: higher payload carrying capability which permits many tasks to be performed with fewer boosters (as well as enabling designers to build more redundance and heavier components into payloads to achieve greater reliability); allows given missions to be performed with smaller boosters; and allows the performance of missions previously considered economically impractical or impossible with current technology. Typically, a radioisotope thruster is a low-thrust, direct-cycle, rocket engine utilizing the thermal energy generated by isotopic decay to heat hydrogen which is then expelled through a nozzle. Isotope heat source technology, thruster design, stage design, low thrust orbital mechanics and mission analyses, and aerospace safety considerations are discussed. (auth)

14734 ADVANCED TECHNOLOGY FOR LARGE SPACE POWER SYSTEMS. Zipkin, Morris A. (General Electric Co., Cincinnati). pp 505-39 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

The development of large space power systems for future space missions of long duration is described. Programs and results in the field of large turbo-nuclear, Rankine cycle, alkali metal working fluid space power systems are reviewed. The scope of the study is limited to the developments relating to energy conversion components. Results of the work to date indicate: evidence of satisfactory corrosion resistance of niobium alloy containment materials; successful fabrication and operation of test facilities utilizing refractory alloy materials; development of alkali metal boiling data at temperatures to 1850°F and condensing of alkali metal vapor at temperatures to 1500°F; electromagnetic pump design innovations to reduce weight; studies of high-speed bearing instabilities; and operation and testing of a potassium vapor test turbine. (R.C.K.)

14735 IMPROVEMENTS IN AND RELATING TO BITHERMAL EXCHANGE PROCESS FOR ISOTOPE ENRICHMENT OF DEUTERIUM. (to Houilleres du Bassin du Nord. du Pas-de-Calais). British Patent 1,097,505. Jan. 3, 1968. Priority date Mar. 17, 1965, France.

In a process for bithermal exchange for isotopic enrichment of D, two phases, one of which is liquid and the other gaseous, selected from the systems H_2O-H_2S, NH_3-H_2, and H_2O-H_2, are brought into countercurrent contact with each other consecutively in a number of cascade-fed stages. Each stage comprises a hot zone, a cold zone, and an extraction zone with the D_2 being recovered from the last of the stages. (B.L.M.)

14736 PULSE GAMMA FACILITY (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1676). 6 drawings.

A shaped pulse gamma irradiator is described. The irradiation system is used to expose specimens to a controlled radiation environment. The shaped pulse is produced by driving a shuttle carrying 1000 Ci of ^{60}Co with an air cylinder. Flux increases from zero to max in 8 msec and decreases from max to zero in 12 msec are producible. Max dose rate is 5×10^4 R/hr. A position indicator and position controller coupled to the drive shaft provide remote operation. The system is designed for fail-safe operation with the pneumatic circuit designed to retract the source in the event of power failure, loss of air pressure, or circuitry malfunction. (For details see TID-4100 Suppl. 44.) (F.S.)

Materials Testing

Refer also to abstracts 14638, 14667, 14756, 15174, 16126, 16247, and 16313.

14737 (CONF-671011-, pp 168-83) NONDESTRUCTIVE MEASUREMENT OF SURFACE RESIDUAL STRESS. McGonnagle, W. J. (Associated Midwest Universities, Lemont, Ill.).

The nondestructive methods of measuring residual stress are, except for the x-ray technique, still laboratory methods. Results of experimental work indicates that there is some correlation between the x-ray and ultrasonic measurements. Although the layer removal correlation between ultrasonic and x-ray measurements does not represent the actual stress distribution of the specimens tested prior to the removal of each layer, the x-ray value does represent the stress values at the surface after each layer removal. Therefore, the correlation shows the feasibility of ultrasonic determination of surface residual stresses. During the experimental work no attempt was made to determine the effect of surface roughness, impurities in or on the surface of the specimens, or the effect of materials variability. Much additional experimental work is required to determine if the ultrasonic technique can be used to give a realistic and meaningful measurement of surface residual stress. (auth)

14738 (CONF-671011-, pp 247-55) INCIPIENT FAILURE DETECTION: A SYSTEM CONCEPT. Balderston, H. L. (Boeing Co., Seattle, Wash.).

The detection of incipient failure of a part, component, subsystem or system is related to the detection of latent defects which already exist in a device, develop during operation of the device, or appear as a result of operational environment, or human error. Defects may also appear as a result of unexpected stress or other unexpected operational hazards. Incipient failure detection is directed to structural defects or chemical contaminates. The detection techniques may include the use of vibration, acoustical energy, electrical noise, infrared, ultraviolet, x-ray, and gamma radiations. Information is presented to indicate how existing knowledge and new research can be combined to develop an incipient failure detection subsystem with broad applicability to aerospace vehicles and ground equipment installations. (J.R.D.)

14739 EVALUATION OF VARIABLES IN THE MEASUREMENT OF FUEL CONCENTRATION VARIATIONS IN NUCLEAR FUEL RODS. Foster, B. E.; Snyder, S. D. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Mater. Eval., 26: No. 2, 27-32(Feb. 1968). (ORNL-P-3335).

A gamma-ray attenuation technique was developed for evaluating the apparent fuel inhomogeneities in vibratory-compacted fuel rods. These inhomogeneities, which appear as fuel concentration changes, result from particle and compaction density variations as well as tube wall and tube diameter variations. Specifications for some of the cylindrical fuel elements have required inspection for inhomogeneity of fueled areas $\frac{1}{8}$ in. in diameter to ±2 per cent tolerance in fuel variation. The types of elements examined ranged from $\frac{5}{16}$ to $\frac{3}{4}$ in. OD. The fuel rods have been stainless steel or Zircaloy tubes filled with compacted UO_2, $(U,Th)O_2$ or PuO_2 particles. Explanations are given on the fabrication of standards and calibration of the system. The discussion also includes empirical data on effects of collimator size, source energy and scanning speeds. (auth)

14740 ULTRASONIC NONBOND INSPECTION OF TUBULAR FUEL ELEMENTS. McCowin, M. L.; Beyer, N. S. (Argonne National Lab., Ill.). Mater. Eval., 26: No. 2, 17-20(Feb. 1968).

An ultrasonic inspection technique used to locate cladding nonbonds of nuclear reactor fuel elements of tubular configuration is described. The aluminum-clad, uranium-aluminum tubes are relatively thin walled (~0.050 in. to 0.060 in.) and vary in diameter from two to four inches. In contrast to the through-transmission techniques more commonly employed for ultrasonic nonbond inspections of thin, flat reactor fuel plates, a reflection method was used for the inspection of these thin-walled tubular elements. The inspection was accomplished by the pulse echo technique using a high-frequency focused transducer and a synchronous monitoring device having a very short delay time. (auth)

14741 GAMMAGRAPHY, ITS PRESENT STATE AND FUTURE POSSIBILITIES. Rubio, A. Ruiz (Centro Nacional de Investigaciones Metalurgicas, Madrid). Energ. Nucl. (Madrid), 11: 309-18(July-Aug. 1967). (In Spanish).

The characteristics of gammagraphy are outlined and compared with the characteristics of radiography. Typical uses of gammagraphy are given. The sources used in industrial gammagraphic installations are described and the creation of gammagraphic services in Spain is discussed. The number of gammagraphic installations in Spain has grown steadily since 1957. The future possibilities of this technique are briefly outlined. (J.S.R.)

Protective Structures

14742 NEW TRENDS IN FALLOUT PROTECTION. Wengrovitz, Seymour; Hirtle, Gordon W. (Office of Civil Defense, Washington, D. C.). Civil Eng. (N. Y.), 35: No. 7, 47-9(July 1965).

The initial phase of the National Fallout Shelter Program carried out by engineers and architects who attended a course developed by Office of Civil Defense is discussed; emphasis is given to incorporation of preplanned dual-purpose shelter areas in original design of new structures; incorporating "slanting" techniques for providing fallout protection. These techniques affect location and quantity of window areas, site conditions, basements, entrances and exits, interior partitions, walls, floors and roofs, and architectural arrangements. (auth)

Radioactive Material Handling

Refer also to abstracts 14639, 14654, 14660, 15141, and 15251.

14743 USA STANDARD PROPOSED DEFINITION OF RADIOACTIVE WASTE CATEGORIES. New York, American Institute of Chemical Engineers, 1967. 10p. (NP-17206).

Proposed definitions of categories of radioactive wastes as developed by the American Standards Association are presented. The following proposed categories are described: Class A (population level); Class B (occupational level); Class C (low level); Class D (intermediate level); and Class E (high level). (R.C.K.)

14744 STORAGE CONTAINER AND PACKAGING (Engineering Materials). (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). (CAPE-1657).

4 drawings.

A storage container and packaging for uranium-233, uranium-235 or plutonium-239 are described. The storage container fabricated of 304 stainless steel 0.065 in. thick and 10 in. in dia may be either $6\frac{9}{16}$ or $12\frac{5}{16}$ in. deep. The packaging is designed for use in a 30 gal drum. The dia of the drum is 20 in. (For details see TID-4100 Suppl. 43.) (F.S.)

14745 UF_6 CYLINDER SHIPPING CONTAINERS PACKAGING (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1662).

8 drawings.

Packaging for 5 in., 8 in., 12 in., and $2\frac{1}{2}$ ton horizontal and end loading cylinders used in shipping UF_6 and other fissionable materials is described. Reinforced high temperature phenolic foam plastic filling is used in all packaging. The $2\frac{1}{2}$ ton cylinders use a 16 gage steel liner and a 14 gage steel outer shell. The 5 in., 8 in., and 12 in. cylinders have 16 gage steel liners and 18 gage outer shells. Foam rubber pressure pads are used in all packaging. (For details see TID-4100 Suppl. 43.) (F.S.)

INSTRUMENTATION

Radiation Detection Instruments

Refer to abstract 14613.

General Detectors and Monitors

Refer also to abstracts 14420, 14677, 15153, 16046, and 16159.

14746 (AERE-M-1848) NEUTRON MEASUREMENTS AROUND NUCLEAR REACTORS. Leake, J. W.; Burt, A. K. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 9p. Dep. CFSTI. UK.

Measurement of the neutron dose equivalent rate at several locations had indicated large differences between the Andersson-Braun detector and the 0072 spherical dose detector (Leake monitor). Part of the discrepancy was attributed to the response of the 0072 monitor to high energy gamma radiation (>3.5 MeV) and part to the differences in the responses of the two detectors when exposed to a narrow beam of neutrons. Observations were made at a number of locations and in the presence of narrow beams of neutrons. The gamma-ray spectrum was analyzed and the response of the 0072 monitor corrected for the high energy gamma dose rate. The measurements showed that where narrow beams of neutrons occur the 0072 monitor will almost always give a higher reading than the dose equivalent rate measured with an Andersson-Braun detector. In a narrow beam of neutrons both monitors underestimate the peak dose equivalent rate because they give a value which is a function of the average value of the neutron flux density over the volume of the detector. The levels of high energy gamma radiation measured were significant, but were too low to account for the larger discrepancies between the 0072 and the Andersson-Braun monitors. It is concluded that the large differences between the 0072 and the Andersson-Braun counter which have been reported are mainly due to the effects of neutron streaming. (auth) (UK)

14747 (EUR-3659) LOW-NOISE PULSE AMPLIFIER FOR Ge(Li) DETECTORS. Benoit, R.; Isabella, L.; Mandl, V. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 13, 1967. 30p. Dep.

A low noise FET input amplifier with a threshold post amplifier has been built. The nominal gain of the amplifier is 1000 and the output range ±10 V; the post amplifier has a variable threshold from 0 to 10 V, a gain of 10 and a maximum output of +10 V. The amplifier was used to study the performances of RLC filters and an improvement in energy resolution of 13% over the conventional RC clipping network has been obtained. (auth)

14748 (GA-8184) DESCRIPTION AND OPERATION OF INTERMEDIATE ENERGY NEUTRON DETECTOR. Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). Aug. 16, 1967. Contract AT(04-3)-167. 25p. Dep. CFSTI.

The design and operation of a plastic scintillation detector system for measuring neutron flux with high efficiency and low background at 100 eV to 10 MeV are described. The collimated neutron beam is intercepted by an absorber which emits fission gamma rays which are detected by the system. (W.H.K.)

14749 (KFK-617) ZUR LEADING EDGE-METHODE MIT IMPULSTRANSFORMATOREN. ERNIEDRIGUNG DER ANSPRECHSCHWELLE DURCH EINEN RAUSCHARMEN SCHNELLEN VORVERSTAERKER. (The Leading-Edge Method with Pulse Transformers. Lowering of the Response Threshold by a Low-Noise-Level Fast Preamplifier). Michaelis, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Sept. 1967. 11p. (In German). Dep.

The introduction of a pulse transformer between a semiconductor counter and a charge-sensitive preamplifier for improvement of the registration of time signals is discussed. The time signals produced with a pulse transformer are described. The development of a low-noise voltage preamplifier for the amplification of fast signals of very low amplitude is described, and the circuit is given. The response threshold for a circuit with and without the preamplifier was determined. The results indicated that the use of the preamplifier increases the sensitivity by a factor of 3. The preamplifier has good linearity. (J.S.R.)

14750 (ORNL-4160) O5S: A MONTE CARLO CODE FOR CALCULATING PULSE HEIGHT DISTRIBUTIONS DUE TO MONOENERGETIC NEUTRONS INCIDENT ON ORGANIC SCINTILLATORS. Textor, R. E.; Verbinski, V. V. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 222p. Dep. CFSTI.

O5S is a Monte Carlo code which directly simulates the experimental techniques used to obtain the pulse height distribution for a parallel beam of mono-energetic neutrons incident on organic scintillator systems. Although the code was developed as part of an effort to accurately calibrate the nominally 2 in. by 2 in. liquid organic scintillator NE-213, it is the intention that the code be readily adaptable to many similar problems. In large part the code is patterned after the far more general code O5R and, for the sake of brevity, at least passing familiarity with that code is assumed. Due to the nature of the specialization which O5S represents, a considerable amount of the memory storage required for O5R is avoided allowing the analysis of neutron events as they occur rather than after all have occurred. Although the code, as here presented, is capable of calculating the pulse height distribution for neutron energies in the range 20 keV to 70 MeV, experimental verification presently exists for the range 200 keV to 20 MeV. The code was written primarily in the FORTRAN 63 language for the CDC 1604-A computer. (auth)

14751 (ORO-3638-1) [FISSION EVENT DETECTION]. Progress Report, May 1, 1967–April 30, 1968. Bridwell, L. (Murray State Univ., Ky. Dept. of Physics). Contract AT(40-1)-3638. 38p. Dep. CFSTI.

The design of an apparatus for detecting fission events, utilizing secondary electron emission, is described. The electron lens and photomultiplier system for detecting fission events with good time resolution is described. Thin film target construction techniques and an IBM 1130 computer-based data acquisition system are reported. Also, measurements taken to determine the mass dependence of heavy-ion stopping power are presented.

14752 (RFP-1046) AIR MONITOR FOR ^{239}Pu UTILIZING SEMICONDUCTOR DETECTOR. Griep, Victor R. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 24, 1968. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

A small compact air monitor was developed which permits continuous sampling procedures for plutonium. To monitor air samples at the many separate locations of a plutonium fabrication facility, a small inexpensive instrument has many advantages. Most commercial air monitors are not only expensive, but constructed in sizes too large for handling alongside other plant equipment. The new monitor is about one-fifth the size and one-fifth the cost of commercial units. The air monitor utilizes a semiconductor detector for sensing alpha-emitting contamination. The air-sampling arrangement consists of a flow meter and assembly to permit quick filter changes; a line-powered, transistorized amplifier and count-rate circuit; a count-rate meter; a warbling alarm; and recorder connections if needed. Included are photographs of the air monitor and schematic diagrams of the circuit and ratemeter boards. (auth)

14753 (STI/PUB-132) LITHIUM-DRIFTED GERMANIUM DETECTORS. Proceedings of a Panel Held in Vienna, June 6–10, 1966. (International Atomic Energy Agency, Vienna (Austria)). Dec. 1966. 225p. IAEA: $5.00; Austrian Schillings 130,-; Pound 1.15.4; F FR 24,50; DM 20,-.

Separate abstracts were prepared for the 14 papers presented. (W.H.K.)

For abstracts of individual papers see: 14798–14803 and 14829–14836.

14754 (UCID-15277) SENSITIVITY OF SOLID STATE DETECTORS TO FLUORESCENT X-RAYS. Ebert, P. J.; Kornblum, H. N. (California Univ., Livermore. Lawrence Radiation Lab.). June 7, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

Preliminary results of calibration of 125- and 250-μ thick silicon detectors using a PAR Model HR-8 Lock in Amplifier for signal enhancement are presented. (B.G.D.)

14755 (UCRL-18005) RECENT DEVELOPMENTS IN LOW-NOISE PREAMPLIFIERS. Elad, Emanuel (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 27, 1967. Contract W-7405-eng-48. 14p. (CONF-680302-1). Dep. CFSTI.

From International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

A novel low-noise preamplifier for use with semiconductor radiation detectors is described. The preamplifier utilizes the low-noise characteristics of a liquid-helium-cooled germanium junction field-effect transistor (JFET). The new germanium device is compared with the currently used silicon JFET's. Pulse generator resolution of the preamplifier for zero external capacitance is 0.28 keV fwhm (Ge) with a slope of 0.018 keV/pF. Typical

resolution obtained with silicon and germanium detectors for low-energy x rays is less than 0.4 keV. (auth)

14756 (UCRL-50007-67-2) HAZARDS CONTROL PROGRESS REPORT NO. 28, MAY-AUGUST 1967. (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 30p. Dep. CFSTI.

The development of various radiation detector systems and associated research for health safety is reported. Topics discussed include a readout system for thermoluminescent dosimeters, design of a flowcounter for krypton-85 in natural gas, gamma dosimetry of plutonium-238–beryllium neutron source, tritium-in-air generator for calibrating tritium monitors, radiation source–detector geometry, development of portable air sampler, safety modifications of a spark-generating device, and testing of ventilation ductwork and hood coating materials. (W.H.K.)

14757 GEOMETRICAL EFFICIENCY OF A SOLID STATE RADIOACTIVITY DETECTOR IN MAMMALIAN TISSUE. Pinter, G. G.; Gloset, E. M.; Kakan, S. (Univ. of Maryland, Baltimore). Int. J. Appl. Radiat. Isotop., 19: 170-2(Feb. 1968).

For measurement of local blood flow in renal tissue a miniaturized solid state radioactivity detector was used, comprising a lithium-activated silicon semiconductor. The detector is contained in a stainless steel hollow needle, with a diameter of 1.5 mm. The wall of the needle is 50 μ thick. The shape and size of the region from which radiation affects the detector were determined. Measurements carried out with ^{32}P and ^{131}I are reported. (auth)

14758 PERFORMANCE OF A HIGH SENSITIVITY LIQUID SCINTILLATION WHOLE-BODY COUNTER. Barnaby, C. F.; Jasani, B. M. (London Univ.). J. Phys., E, 1: 91-8(Feb. 1968).

The design and performance of the counter are described. The liquid scintillator used is based upon medicinal paraffin, and total internal reflection is used as the method of light collection. The counter is therefore cheap, and safe from fire hazard. The performance and sensitivity were shown to be adequate for the accurate determination of body ^{40}K, and the potassium content of a normal (70 kg) man can be measured to 2% accuracy of counting statistics in a counting time of 300 seconds. The counter is, therefore, suitable for experiments in which the counting of numerous persons is required. Calibration is simple, and this is one of the main advantages of the design. The performance is compared with other high sensitivity counters, and possible uses are discussed. For cheapness, chalk is used as the main shielding material. (auth)

14759 LONG-LIVED PHOSPHORESCENT COMPONENTS IN NaI(Tl) AND CsI(Tl). Delaney, C. F. C.; Lamki, A. M. (Univ. of Dublin). Int. J. Appl. Radiat. Isotop., 19: 169-70(Feb. 1968).

In a calibration experiment on 6 keV iron-55 x rays, using a scintillation counter, a large and seemingly stable background of single electron pulses was observed. This background was much more than could be accounted for by thermionic noise in the photomultiplier, and was found to be due to very long term phosphorescence in the crystal used. A control run with a disc of quartz of the same dimensions as the crystal yielded phosphorescence very much less in magnitude, and decaying far more rapidly. Long-lived phosphorescent components of NaI(Tl) with mean lives up to 90 min have been reported. Those observed by the authors appeared to have decay periods of the order of days, and it was therefore thought worthwhile to make a few observations on them. (auth)

14760 ANOMALOUS EFFECT IN A LITHIUM-DRIFTED GERMANIUM SEMICONDUCTOR DETECTOR. Walford, G.; Doust, C. E. (Univ. of Surrey, Sutton, Eng.). Electron. Lett., 4: 13(Jan. 1968).

After the installation of a lithium-drifted germanium gamma-ray detector in a vacuum cryostat at 77°K, a negative differential resistance was observed that was stable and measurable using dc methods. The measured characteristics obtained are described. (auth)

14761 A WHOLE-BODY COUNTER FOR DETERMINATION OF THE ABSORPTION OF ^{58}Co-VITAMIN B_{12}. Simpson, J. D.; Shearman, D. J. C. (Royal Infirmary, Edinburgh). Phys. Med. Biol., 13: 61-7(Jan. 1968).

A simple scanning-type inexpensive whole-body counter is described which has been successfully applied clinically to studies of the absorption of ^{58}Co-vitamin B_{12}. Comparisons between whole-body counter and faecal measurements indicated that the latter method gave erroneous results due to incomplete collections in over 25% of cases. (auth)

14762 SEMICONDUCTOR NUCLEAR RADIATION DETECTORS. Tavendale, A. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Annu. Rev. Nucl. Sci., 17: 73-96(1967).

The present state of semiconductor detector technology and performance is reviewed. Topics discussed include classification and fabrication, resolution and detection efficiency, charge production and collection, and detectors for special applications. (W.H.K.)

14763 SEMICONDUCTOR DETECTORS IN NUCLEAR PHYSICS RESEARCH. Dearnaley, G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 273-98 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A historical survey of the development of semiconductor detectors is given, and it is shown why they are superior to the earlier crystal counters. The physical processes which occur during the detection of nuclear radiation in a solid state device are considered in detail and the merits of the reverse-biased semiconductor junction in silicon and germanium are set out. Factors determining the energy resolution of such a detector are analyzed, and the effects of radiation damage are considered briefly. The preparation of the most important types of detector is outlined in its simplest form and some of the physical principles involved are discussed. A survey is then made of the applications of semiconductor detectors in nuclear physics, for charged particle spectrometry, beta and x-ray spectrometry, neutron detection, fission experiments and the rapidly developing field of gamma ray spectrometry. (auth)

14764 PROBLEMS USING TWO-DIMENSIONAL PULSE HEIGHT ANALYSIS. Alburger, David E. (Brookhaven National Lab., Upton, N. Y.). pp 321-42 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

Recent research at Brookhaven making use of two-dimensional pulse-height analysis is reviewed. Particle–gamma, gamma–gamma, and particle–particle coincidence effects are discussed and examples are given of research problems carried out at both the 3.5-MeV Van de Graaff and the 60-in. cyclotron. The computer techniques of data simulation, light pen applications, and associative-memory storage are mentioned in connection with particle-particle coincidence analysis. (auth)

14765 INTERNAL LIQUID SCINTILLATION COUNTING APPLIED TO THE ABSOLUTE DISINTEGRATION-RATE MEASUREMENT OF ELECTRON CAPTURE NUCLIDES. Steyn, J. (National Physical Research Lab., Pretoria). pp 35-45 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The nuclides chromium-51, manganese-54, cobalt-57 and zinc-65 have been standardized by counting coincident radiation with a sodium iodide gamma scintillation counter, and an internal liquid scintillation counter containing the source in solution. Coincidence measurements were made at different values of x-ray plus Auger-electron counting efficiency. This variation of counting efficiency was obtained electronically by varying the amplification and/or the discrimination level. It is shown how a graph of x- plus Auger counting rate against the ratio C/G, where C and G are the coincidence and gamma counting rates, respectively, is a straight line which can be extrapolated accurately to give the disintegration rate of the source. This extrapolation corrects for complications caused by the gamma ray contribution in the liquid scintillation detector. The standardization results were compared with coincidence counting of deposited sources in a conventional 4π proportional counter gamma counter coincidence arrangement. The nuclides chromium-51, manganese-54 and zinc-65 were further used to establish a graph of counting efficiency against K x-ray energy. This could then be used to find the counting efficiency of the liquid scintillation counter for the pure electron capturing nuclide iron-55, and thus the disintegration rates of sources of this nuclide. The method demands that sources of the above-mentioned nuclides be counted at least once under identical experimental conditions. After the calibration curve has been obtained, however, it is only necessary to count samples of any one of the above gamma-emitting nuclides together with the iron-55, either as internal or external standard, to obtain the disintegration rate of the iron-55 samples. Results are presented, illustrating the degree of precision and reproducibility obtained. (auth)

14766 DEVELOPMENT OF A 4π LIQUID SCINTILLATION COUNTING METHOD FOR THE ABSOLUTE STANDARDIZATION OF RADIOACTIVE SOLUTIONS WITH PARTICULAR REFERENCE TO EFFICIENCY TRACING MEASUREMENTS. Bryant, J.; Jones, D. G.; McNair, A. (Radiochemical Centre, Amersham, Eng.).

pp 47-53 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The liquid scintillation counting method is shown to have special advantages when applied to the absolute standardization of beta emitters by the efficiency tracing technique. The simplicity of producing sources in which the active constituents are uniformly mixed, and the relative insensitivity of the method to physical and chemical effects in the sources are particularly evident. The extrapolation to 100% efficiency (zero energy) is discussed and it is shown that the normal linear extrapolation is not generally valid. The nonlinearity is caused by differences in the beta spectra of the two radionuclides but the degree of nonlinearity depends on the characteristics of the equipment transforming the beta spectrum into a pulse-height spectrum. For example, some events fail to produce even a single photoelectron at the photocathode and the signals from some others are lost in the noise from the photomultiplier. The number of events so lost depends on the equipment and on circumstances of the measurement, and it is not reasonable to assume that the losses will remain constant unless this can be verified experimentally. Apparatus for investigating these losses is described and its sensitivity to such effects as the nonlinearity of scintillant response to beta-particle energy is discussed and shown to be small. The application of the method to routine efficiency tracing measurements is expected to lead to significant improvements in reproducibility and accuracy. (auth)

14767 THEORETICAL ANALYSIS OF THE $4\pi\ \beta-\gamma$ COINCIDENCE METHOD. Thomas, J. (Technical University of Denmark, Lyngby). pp 79-88 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

After an analysis of the statistical behavior of a $\beta-\gamma$ coincidence system the probability distribution of the absolute activity of the radioactive source is found. The mean value and the standard deviation of this probability distribution are evaluated. It is further shown how the substitution method can be used to determine the count-rate-dependent corrections. (auth)

14768 ACCURATE DETERMINATION OF THE STABILITY OF β-PROPORTIONAL GAS COUNTERS AGAINST VARIATIONS IN THE ENERGY THRESHOLD. Loevborg, L. (Research Establishment Riso, Roskilde, Denmark). pp 103-12 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The stability of the response probability of a counting channel against small variations in the energy threshold in terms of a sensitivity factor, defined as the ratio between a relative change in the response probability and the relative variation in the energy threshold producing this change, is discussed. According to this definition the sensitivity factor is equal to the intensity at the energy threshold of the pulse-height spectrum obtained from the radiation counter, divided by the area under this spectrum, the pulse height being expressed with the energy threshold as unity. In a β-counting channel supplied with a proportional gas counter, a minimum exists in the lower end of the pulse-height spectrum as a result of the superposition of a primary spectrum due to the ionization caused by the β-particles in the counting gas, and a secondary spectrum which is attributed to after pulses. The latter spectrum is correlated with the former; this, in connection with the fact that the primary spectrum depends on the energy spectrum of the β-particles, indicates the existence of a relation between the smallest obtainable sensitivity factor and the end-point energy of the nuclide. This relation was investigated in the case of a windowless 2π gas-flow counter for β-emitting nuclides with end-point energies in the range from 0.167 to 1.70 MeV. It was found that the smallest obtainable sensitivity factor increased from 0.50% to 4.1% when the end-point energy was reduced from the upper to the lower of the above-mentioned limits. For end-point energies higher than about 0.25 MeV, the relation could be described by a simple analytical expression, regardless of the shapes of the β-spectra. Such a description of the counting channel is more satisfactory than the usually specified plateau slopes of the high-voltage characteristics, since it allows a direct comparison with regard to stability between counting channels of different designs and modes of operation. (auth)

14769 ADVANTAGE OF ANTICOINCIDENCE COUNTING FOR STANDARDIZING RADIONUCLIDES EMITTING DELAYED GAMMA RAYS. Bryant, J. (Radiochemical Centre, Amersham, Eng.). pp 129-33 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The coincidence method for standardizing radionuclides cannot be directly applied where one of the radiations from a disintegration is delayed. For short delays the usual coincidence circuit arrangements may be used, provided that the coincidence resolving time is sufficiently long so that most of the associated radiation signals are accepted as coincidences. It is necessary to make corrections for lost coincidences and for accidental coincidences. These corrections are complex and there appears to be no complete theory for them at present. By using the anticoincidence counting method described previously to obtain the coincidence or associated pair count rate the correction for accidental coincidences is avoided. Further, the anticoincidence gate can be arranged so as to ensure that delayed radiation signals are accepted as anticoincident or unassociated only if they follow signals in the other channel by at least some minimum chosen time. By making this time equal to a number of half-lives of the transition producing the delayed radiation, the number of signals incorrectly recorded as unassociated may be made as small as desired. The correction for these signals can thus be made very small, and the only other counting corrections required are those for dead-time losses, which are well understood. The method has been applied to the standardization of strontium-85. (auth)

14770 RESPONSE OF 4π PROPORTIONAL COUNTERS TO γ RAYS. Merritt, Janet S.; Taylor, J. G. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 147-52 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The response of a 4π proportional counter to γ-rays has been measured as a function of γ-ray energy by the $4\pi\ \beta-\gamma$ coincidence-absorption method. The results, which are about a factor of three lower than those obtained using thick absorbers, are slightly lower than, but in general agreement with, those of Williams and Campion. Electrons produced by γ-ray interactions in the absorber are responsible for the higher results obtained with thick absorbers. This effect has been demonstrated by determining the γ-ray response of a 4π proportional counter as a function of absorber thickness for the 478-keV γ-rays of ^{7}Be. In addition, the responses to 478-keV γ-rays of five different 4π proportional counters have been compared. For one of these, a pressurized 4π proportional x-ray counter, the response has also been measured as a function of filling pressure. It is concluded that the intrinsic γ-ray response of 4π proportional counters is small and, if γ-ray absorption in the counting gas may be neglected, is not strongly dependent on the size, shape or material of the cathode. (auth)

14771 THREE-COUNTER SYSTEM FOR ABSOLUTE MEASUREMENT OF SOURCE ACTIVITY BY THE COINCIDENCE METHOD. Philis, C. (Commissariat a l'Energie Atomique, Paris). pp 195-202 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

With the new method of absolute measurements proposed, it is possible to dispense with the nuclear constants needed for absolute measurements by the beta-gamma coincidence method in the case of isotopes with decay schemes including a beta branching and a partial gamma conversion. After an explanation of the principle involved, the method applied to the measurement of two dense sources (^{203}Hg and ^{141}Ce) together with the experimental results obtained are described and the activity values obtained for one and the same sample with different methods are compared. (auth)

14772 APPLICATION OF LOW-GEOMETRY COINCIDENCE METHODS TO MEASUREMENTS OF DISINTEGRATION RATES. Kowalski, E.; Binkert, Th.; Siegenthaler, R.; Meyer, K. P. Univ. of Bern). pp 203-9 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The results of investigations on coincidence methods employing scintillation counters with small solid angles and efficiencies different from unity are reported. Two single radiations or two groups of radiations can be used in this coincidence measurement. The counter responses to both radiations or radiation groups must be made approximately equal. Due to the low geometry of the detectors used, the effects of sum-event pulses, angular correlation of the coinciding radiations, coincidences by scattering and coincidences between radiations belonging to the same radiation group must be considered. The $\gamma-\gamma$, $x-\gamma$ or $x-x$ measurements offer advantages in calibration of sources with doubtful radiochemical

purity if the coinciding radiations are selected in a correct manner. Another interesting application is to measure the source strength of radioactive solutions in glass ampoules without opening the ampoules. Neutron-activated foils can also be calibrated directly, without the previous preparation of a solution and a weightless source. Cascades of highly converted γ-rays can be measured by means of an x–x coincidence method. Of course, the low geometry coincidence measurements can also be done by the use of particle radiations. The main limitations of the methods quoted lie in the very long time required for one measurement and in the sensitivity of the method to coincidences by scattering. The elimination of coincidences by scattering becomes difficult if hard γ-rays are present in the measurement for which the pair-production probability is high. The main value of the low geometry coincidence methods lies in the possibility of cross-checking with some other calibration methods or auxiliary techniques (e.g. to test the dilution accuracy) by means of an independent absolute measurement, rather than in making routine measurements on large numbers of sources. (auth)

14773 MEASURING THE ABSOLUTE ACTIVITY OF A ^{58}Co SOURCE WITH A COINCIDENCE DEVICE. de Swiniarski, R. (Paris Univ., Orsay, France); Czerny, J.; Bolliet, R.; Lloret, R. pp 223-33 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Knowledge of the absolute activity of ^{58}Co sources is of great value for determining the fast-neutron flux in a reactor. This activity was measured from β^+-γ de-excitation with a coincidence device: a β^+-signal obtained from the rapid coincidence (resolving time 6 ns) of annihilation gammas is made to coincide (resolving time 0.6 μs) with the signal for 810-keV gammas. By this method it is easily possible to measure activity in a range extending from several 10^4 to several 10^6 disintegrations per second. Under the best conditions, which are obtained at several 10^5 disintegrations/s, an accuracy of 1% is reached. Intercalibrations carried out between 1963 and 1965 showed good agreement between different laboratories. (auth)

14774 DETERMINATION OF CORRECTIONS IN THE ABSOLUTE MEASUREMENT OF ^{137}Cs. Spanel, J.; Zderadicka, J. (Inst. for Research, Production, and Application of Radioisotopes, Prague). pp 235-44 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

A method of determining corrections in absolute measurements of ^{137}Cs by 4π proportional counter is described. The correction for self-absorption of ^{137}Cs beta particles from sources formed by vacuum deposition of CsCl on standard carrier films was determined. These samples, which had negligible self-absorption, were measured by 4π counter. The radioactive substance on the film was then dissolved, and by the addition of carrier was converted to a form similar to that of sources usually used for absolute measurement. The correction determined for self-absorption was higher than the value expected from comparison with other radionuclides having near Es_{max}. The correction for internal conversion coefficient and gamma efficiency of the beta detector was determined with ^{137m}Ba samples. Barium was separated as $BaSO_4$ precipitate and deposited on a standard carrier film used for absolute measurement with a layer thickness of about 1 mg/cm^2. These samples were simultaneously measured by means of a 4π beta proportional counter and a NaI(Tl) scintillation counter. From corresponding counting rates in both counters, and from both known efficiencies, the value for a correction appropriate to one disintegration of ^{137m}Ba was calculated. The values measured were used further for computation of the internal conversion coefficient and the half-life of ^{137m}Ba, which was ascertained to be 155 ± 3 s. (auth)

14775 ABSOLUTE MEASUREMENT OF ^{14}C ACTIVITY BY INTERNAL PROPORTIONAL COUNTERS. Kits, J.; Kokta, L.; Bucina, I. (Inst. for Research, Production, and Application of Radioisotopes, Prague). pp 267-75 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

$^{14}CO_2$ was obtained by decomposing carbonate with sulphuric acid heated to boiling point, after which it was mixed with CH_4 in a reserve flask. Three brass internal proportional counters, differing only in length, were filled with this mixture. The counters were connected to the electronic equipment in the usual arrangement. The equipment dead time was determined by means of a modified two-source method, and the total volume of the equipment was obtained from the isothermic expansion of methane from a flask whose volume, together with that of the counters, had been determined by weighing a water filling. The wall effect was determined by measuring a $^{14}CO_2 + CH_4$ mixture at different pressures and by extrapolation to reciprocal pressure zero value; it was discovered that the wall-effect correction did not differ significantly from zero. The end effect was compensated for by using counters of different lengths so that the difference in plateau slope also did not differ significantly from zero. By the t-test function it was estimated that the maximal error on a 0.01 significance level, caused by neglecting the wall-effect correction, amounted to ±0.85% due to the end-effect correction (±0.62% for the equipment used) having been neglected. The relation between wall, end and discrimination effects is discussed, and, in conclusion, the maximal errors from other sources are estimated; the total maximal error on a 0.01 significance level of the standard solution activity is computed as equal to ±1.1%. (auth)

14776 INTERNAL GAS COUNTER AS A PRECISION ABSOLUTE COUNTING DEVICE. Spernol, A. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 277-87 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The internal gas counter is the most accurate device for the absolute counting of low energy radiations. Its usefulness can be extended to higher energies if the possible error effects are investigated and corrected thoroughly and the measuring conditions are properly chosen. The different sources of error in internal gas counting, e.g. field distortion by the isolators and guard tubes at the counter ends, irradiation from the ineffective end volumes into the counting volumes, escape from the counting volume into the ends and walls, all kinds of sorption effects, and counting loss due to the finite energy discrimination during counting, are discussed in detail. The optimum counter design is derived from this discussion. The corrections for these error effects can be described with simple semi-empirical formulas, which depend only on a few constants which have to be determined. Measurements of T, ^{14}C, ^{35}S, ^{37}Ar, and ^{85}Kr at counting-gas pressures of 200-750 torr have been performed. They make it possible to determine all corrections in internal gas counting, depending on the energy and kind of the radiation and on the counting-gas pressure. This determination has been done by using empirical extrapolation techniques as well as the derived formulas. The results make it possible to correct nearly every internal gas counting measurement of β-radiations, electrons and x rays and to obtain final accuracies of 1%. Some examples of such measurements—the determination of the decay scheme of ^{85}Kr, the measurement of the fluorescence yield of ^{37}Cl and the half-life determination of ^{131m}Xe—are discussed briefly. (auth)

14777 COINCIDENCE METHOD OF STANDARDIZATION FOR THE PURE ELECTRON CAPTURE NUCLIDE, ^{131}Cs. Troughton, Mary E. (Radiochemical Centre, Amersham, Eng.). pp 323-39 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Cesium-131 decays by electron capture to the ground state of xenon-131 without gamma emission. Capture from the K shell predominates, but about 12% of the disintegrations occur by L capture. Vacancies in the L shell are also frequently produced when K shell vacancies are filled. This is the basis of the K-L coincidence method, described by Allen, for measuring the disintegration rate. The theory of Allen's method is amended so as to distinguish between the number of L shell vacancies formed simultaneously with the K x rays and the number associated with K Auger electron emission. A correction is also applied for M shell capture. The method is adapted for use with a 4π β-γ (proportional counter/NaI crystal) coincidence equipment. The output of the NaI crystal system is gated on the full energy pulses from the xenon K x rays. A correction is made for the escape of iodine x rays from the crystal in the detection of xenon K_β x rays. In the proportional counter spectrum, the pulses resulting from the filling of L vacancies are distinct from those arising from the filling of K vacancies (K events), and a narrow gate is set to accept the former. The expression for the disintegration rate allows for the small number of K events which count within the gate. L events are deleted from the observed counting rate by summation out of the gate whenever simultaneous K events are detected in the proportional counter. A correction is therefore made, in the equation for the disintegration rate, for the pulses which are produced above the gate by K events (usually K Auger electrons). Because the number of L vacancies in coincidence with K Auger electrons is not well known, the accuracy of the method is improved when the K Auger electrons are detected

with high efficiency, by using a thin source in 4π geometry. It is not strictly accurate to assume that all the remaining L shell vacancies are detected with equal efficiency, because the L vacancies produced in association with K x-rays are in L_{III} and L_{II} sub-shells, whereas those formed by capture of L shell electrons are mainly in the L_I sub-shell. The different fluorescence yields for the various L sub-shells lead to an additional correction term. (auth)

14778 X-RAY–X-RAY COINCIDENCE COUNTING METHODS FOR THE STANDARDIZATION OF ^{125}I AND ^{197}Hg. Taylor, J. G. V. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 341-54 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

^{125}I and ^{197}Hg are two examples of radionuclides for which standardization by coincidence counting is complicated by the fact that the principal x-rays or γ-rays from the coincident transitions have the same or nearly the same energies and are not resolved by the detectors. On the other hand, unlike γ-γ coincidence counting at higher energies, x-x and x-γ coincidence measurements do not require corrections for angular correlations or (for energies <100 keV) for Compton scattering. It is shown that when these latter effects may be neglected coincidence equations which include the effects of coincidence summing and the ratios of the response probabilities per disintegration for the two radiations may be solved without making the usual approximations. Two cases are considered in which the range of pulse heights accepted in in each channel includes all sum coincidence events, and the range of pulse heights accepted completely excludes such events. The exact solutions are cumbersome in the general cases but reduce to relatively simple expressions under experimental conditions which usually obtain in practice. By suitable approximations these expressions in turn may be reduced to formulas quoted in the literature. Coincidence measurements of ^{125}I and ^{197}Hg for different counter geometries and channel window settings are described and shown to give consistent values for the disintegration rates only if the new formulas are used. Since the ^{125}I results are relatively insensitive to uncertainties in the decay scheme parameters, the systematic error in determining the disintegration rate of a source is believed to be <±1%. The ^{197}Hg results are much more dependent on the details of the decay scheme which at present rely heavily on theoretical capture ratios and conversion coefficients. For this reason the systematic error in the standardization of ^{197}Hg by x_K-γ coincidence counting taken alone might be as much as 5%. In attempts to reduce this uncertainty both 4π (ce, e_A)-($x_{K,\gamma}$) and x_L-x_L coincidence measurements of ^{197}Hg have been studied. Within the uncertainties of 2 to 3%, due to approximations or decay scheme dependent factors entering into their analysis, these measurements confirm the $x_{K-\gamma}$ coincidence results. (auth)

14779 PRECISE COINCIDENCE COUNTING OF CONVERSION ELECTRONS. Hansen, H. H.; Delabaye, M. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 361-9 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Various methods currently used for determining internal conversion coefficients are reviewed, together with their main advantages and drawbacks. These techniques are especially discussed with respect to their possible accuracies. Coincidence methods are treated in more detail for the most promising cases of simple decay schemes and their possible accuracy is estimated. To demonstrate the coincidence technique the K conversion coefficient α_K was determined for the 662-keV γ-transition in ^{137}Ba as well as the K conversion probability η_K for the 166-keV γ-transition in ^{139}La. The radiations were detected by a double-focusing, sector-type magnetic β-spectrometer connected to two NaI(Tl) scintillator spectrometers. (auth)

14780 PRECISE SOLID-ANGLE COUNTING. Bambynek, W. B. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 373-83 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The principle of solid angle counting is described and the corrections are reviewed which must be applied to the measured counting rates to calculate the disintegration rates. The main correction is that for the solid angle subtended by the diaphragm. All other corrections are due to scattering or absorption effects, which depend on the kinds of detectors, transmission through, and scattering at, the diaphragm, absorption and scattering between source and detector, and absorption and scattering inside the source and the backing are discussed with respect to the different radiations and energies. The investigation of the errors connected with these corrections makes it possible to find out for which radiations and which energy intervals the method is the most promising. For these cases all the considered sources of error have also been investigated experimentally. The results confirm the theoretical estimations and permit precise deduction of the obtainable accuracies. Some recent examples of high-precision solid-angle counting on suitable radiations are described in detail. (auth)

14781 SYSTEM FOR COMPARING GAMMA SOURCES VARYING BY RATIOS OF UP TO 1:1000. Tejera Rivera, A.; Navarro Cuevas, D. (Univ. Nacional Autonoma de Mexico). pp 419-22 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Two nonelectronic devices have been constructed permitting continuous and reasonably accurate amplification by a factor of up to 100 of the counting capacity of a scintillation system. This system is designed for use in comparing the activities of radiation sources, mainly on the gamma type, and also the activities of one and the same radioisotope, when they differ by a ratio of the order 1:1000. The immediate use of the system is in the preparation of gamma standards for the calibration of ionization chambers requiring radioisotope (e.g., ^{60}Co and ^{131}I) activities in millicuries, on the basis of corresponding standards with activities of the order of microcuries. The basic principle involved is to limit the passage of light through the scintillation crystal to the photomultiplier tube. In the first device, half the face of the NaI(Tl) scintillation crystal and half the face of the photomultiplier are screened in such a way that rotation of the crystal causes the screens to be superimposed and the amount of light is cut down by from 50% to nil. With this device, it has been possible in practice to compare activities varying by 1:20. The second device is fitted with five diaphragms on a rotating disk which permit the passage of light to be regulated from 100% to nil. Using this device, it is possible to compare sources varying in activity by ratios of up to 1:1000, keeping the scaler reading within the limits of 100,000 counts/min. The main advantage to this procedure is that error due to differences in counter dead time for counts on sources varying widely in activity is reduced; further, samples of this kind can be compared using small-size shielding. (auth)

14782 PRECISION 4π GAMMA IONIZATION CHAMBER WITH MINIMAL POSITION DEPENDENCE. Bucina, I.; Zalesky, K.; Kucera, P. (Inst. for Research, Production, and Application of Radioisotopes, Prague). pp 431-41 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

A spherical, well-type, 4π gamma ionization chamber was designed for precise relative measurement of gamma sources, especially ^{226}Ra standards. Ionization current dependence on the source position was eliminated by means of a spherical filter. Position dependence caused by source deviation from center, due to mean distance change from ionization volume, was compensated for by a position dependence of opposite sign, due to increased gamma absorption resulting from changing the mean effective filter thickness. The optimal filter thickness for ^{226}Ra of 5 mm was chosen by numerical calculation according to the equations given in the Appendix. The experimentally determined position dependences are shown. Ionization current change, due to source deviation of up to 25 mm, can be decreased to less than 0.3%. The spherical electrodes of the ionization chamber consisted of a layer of graphite varnish deposited on dentacryl walls. The radii of the electrodes were 101 and 128 mm, respectively. The effect of the absorption of gamma radiation in the radium salt and in the standard ampoule walls was decreased to a minimum by a 5-mm lead filter and by the production of mainly Compton electrons in the chamber walls, which were made of a material of low atomic number. The efficiency of the chamber was 11 pA per mg Ra and the background was 0.05 pA. A saturation current at only 200 V is still guaranteed to 1 Ci ^{60}Co due to suitable construction of the insulators. The ionization current was measured by the automatically compensating Townsend scheme with a vibrating-reed electrometer. The measurements were reproducible with a standard deviation of ±0.19% for 1 mg Ra. Relative comparison of two ^{226}Ra standards with radium content of 1 to 30 mg could be made with a precision of ±0.08 to 0.05% for 15 repeated measurements. The above-mentioned principle of compensation for position dependence will be used to design a pressure cylindrical 4π ionization chamber also intended for activity measurements of μCi order. (auth)

14783 PRECISE MEASUREMENT OF EXTENDED BETA SOURCES. Vaninbroukx, R. L. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 443-50 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

In accelerators and reactors irradiation probes of rather large dimensions are often needed. Accurate determination of the activities of such extended probes can be very difficult. This is especially true if the end product are pure β-emitters, as is the case with the fast-neutron monitors ^{31}P and ^{32}S, which are based on the reactions $^{31}P(n,p)^{31}Si$ and $^{32}S(n,p)^{32}P$. Various methods that can be used for determining the activity of extended samples of ^{31}P and ^{32}S with homogeneously distributed ^{31}Si or ^{32}P, respectively, were investigated. Bremsstrahlung counting was used as a nondestructive relative method. Under suitable conditions, especially by surrounding the sample with a source-holder of the same, but inactive, material as the sample itself, a reproducibility of 0.5% and an accuracy of 1% can be reached. The error is mainly due to the calibration and to the low efficiency of about 0.5%, which, in addition to the high γ-sensitivity, limits the application of this method to very pure β-samples of activities that are not too low. After dissolution of the sample different destructive methods can be applied. Absolute liquid scintillation counting can be advantageously used if the solution can be mixed with a liquid scintillator. This is in general not the case with ^{31}P and ^{32}S samples. Therefore three relative methods have been investigated: Cherenkov radiation counting, end-window β-counting, and bremsstrahlung counting of aqueous solutions of the samples. Under properly chosen conditions all three methods are at least 0.5% reproducible and better than 1% accurate. The Cherenkov radiation method seems to be especially suitable for the measurement of the β-radiations of higher energy discussed here, because of the high efficiency of ~30%, the low background and the inefficiency against low energy β- and γ-radiation. (auth)

14784 INSTRUMENTAL ERRORS OF NUCLEAR RADIATION TRANSDUCERS MEASURING DEVICES. Popescu, A. Stud. Cercet. Energ. Electroteh., 17: 225-39(1967). (In Rumanian).

The measurement accuracy of nuclear radiation transducers is largely influenced by the instrumental errors. The way these errors occur and a general method for their calculation are exposed. It is proved that the instrumental errors are comparable to, or even higher than statistical ones, so that they cannot be possibly overlooked. (Rom. Sci. Abstr.).

14785 TECHNOLOGICAL PROBLEMS IN PRODUCTION OF HALIDE GEIGER-MUELLER COUNTERS. Miac, Ryszard (Inst. for Nuclear Research, Warsaw). Przegl. Elektron., 8: 600-3(Dec. 1967). (In Polish).

Recovery time and counting characteristics of a AOH-42 type Geiger-Mueller counter are discussed. (R.V.J.)

14786 PREPARATION OF SOLID STATE DETECTORS BY HIGH-TEMPERATURE DIFFUSION. Fernandez, A. (Comision Nacional de Energia Nuclear, Mexico). pp 193-6 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967. (In Spanish).

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

With a view to the preparation of solid state detectors that could be used for the dosimetry of electrons of a wide energy region, the diffusion of phosphorus in single crystals of p-type silicon was studied for various diffusion times, thus modifying the curve representing the concentration of impurities in the detector. From these curves operational characteristics can be inferred that may be valuable in the above-mentioned manufacturing process. (auth)

14787 MONTE CARLO CALCULATION OF SOURCE-TO-DETECTOR GEOMETRY. II. Williams, I. R. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 60: 4-6(Feb. 1968).

An outline is given of numerical integration by the Monte Carlo method for calculating the transmission of an ion-optical system. The technique is extended to determine an intensity map of the image. (auth)

14788 MONTE CARLO STUDIES OF SCINTILLATOR EFFICIENCIES AND SCATTER CORRECTIONS FOR (n,2n) CROSS SECTION MEASUREMENTS. Parker, J. B.; Fieldhouse, P.; Harrison, L. M.; Mather, D. S. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 60: 7-23(Feb. 1968).

The use of Monte Carlo methods to calculate the neutron detection efficiency of a gadolinium-loaded scintillator is described. A multiple scatter Monte Carlo program to assist in the experimental determination of (n,2n) cross sections using the scintillator is also described and illustrated. (auth)

14789 POSITION SENSITIVE DETECTORS MADE BY ION IMPLANTATION IN SILICON. Laegsgaard, E.; Martin, F. W.; Gibson, W. M. (Aarhus Univ., Denmark). Nucl. Instrum. Methods, 60: 24-6(Feb. 1968).

Implanted dopant ions are used to form the resistive layer in position sensitive p-n junction particle detectors. Position resolution of 0.2 mm fwhm and linearity of ±0.3 mm are obtained. (auth)

14790 SOME NUMERICAL ESTIMATES FOR THE EAS DETECTION AS CHERENKOV PULSES. Mahesh, Krishan (Kurukshetra Univ., India); Srivastava, B. N. Nucl. Instrum. Methods, 60: 27-8(Feb. 1968).

Some numerical estimates for the rf part of the Cherenkov radiation energy associated with the incoming extensive air showers that can possibly be received by a suitable antenna system are made at various shower energies and radio waves. The signal/noise ratio is computed at these shower energies and radio wavelengths. It is felt that at $E \geq 10^{17}$ eV the signal/noise is substantial so as to make possible the EAS detection. (auth)

14791 PROPOSAL FOR A NEW ORGANIZATION OF DECISION ELECTRONICS IN MULTICOUNTER EXPERIMENTS. Schiavuta, E. (Univ., Padua); Soso, F. Nucl. Instrum. Methods, 60: 36-44(Feb. 1968).

In view of the introduction of integrated logic elements into prompt electronic modules, a new correlation unit is studied. By examining typical experimental requirements, it is shown that for optimum efficiency the unit should produce any logical function of n binary variables in a time not much longer than that required for usual coincidence-anticoincidence operations and switch easily on external program from one function to another of the same variables. Practical block diagrams for such correlation modules are then analyzed. It is seen that, up to 4-5 variables, cost and complexity are not much larger than for a conventional electronic module. (auth)

14792 MASS AND ENERGY DISTRIBUTION OF FISSION FRAGMENTS FROM THEIR RANGES IN SOLID STATE DETECTORS. Ait-Salem, M.; Gerhardt, H.; Goennenwein, F.; Hipp, H.; Paap, H. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods, 60: 45-51(Feb. 1968).

A method is given to take mass and kinetic energy distribution of fission fragments with solid state detectors. The target material is evaporated on two detector foils (acetylcelluloid in the present experiment) and the foils arranged to form a sandwich during irradiation and scanning under the microscope. This allows to measure simultaneously the ranges of the two correlated fragments in binary fission. An empirical range-energy relation for heavy ions in several stopping materials has been set up. Using this relation and — apart from minor corrections — mass and momentum conservation, the mass and energy of the fission fragments are calculated event by event. The results of an experiment on $^{238}U(n,f)$ induced by 15.3 and 4.65 MeV neutrons are compared with the findings obtained by other techniques. From the comparison range straggling data are found. (auth)

14793 SILICON DETECTORS ABOARD SURVEYOR V. Tuzzolino, A. J.; Kristoff, J. J.; Perkins, M. A. (Univ. of Chicago). Nucl. Instrum. Methods, 60: 61-9(Feb. 1968).

The system of silicon detectors which were designed for the alpha-scattering experiment aboard the Surveyor soft-landing missions to the moon is discussed. The purpose of the alpha-scattering experiment is to perform a chemical analysis of the lunar surface. The detector requirements imposed by this experiment and the operating characteristics of the silicon detectors in the instrument aboard Surveyor V are discussed. The performance of the detectors on the Surveyor V lunar mission is reported. (auth)

14794 AUTOMATIC COMPENSATION FOR FLUORESCENCE EXTINCTION IN LIQUID SCINTILLATORS. Jordan, P.; Kaczmar, U.; Koeberle, P. (Ecole Polytechnique Federale, Zurich). Nucl. Instrum. Methods, 60: 77-87(Feb. 1968). (In German).

A procedure for the liquid scintillation counting of weak β-emitters, which permits automatic compensation for the effects of quenching, is presented. Prior to each measurement the spectrum of an auxiliary radiation source, γ- or α-, is superposed on the sample. Should that sample be quenched, there is a depression of the count rate of the auxiliary source measured in an analysis channel whose settings make the count rate therein strongly dependent on the degree of quenching. The count rate of the source may be restored to its unquenched value through readjustment of one of the efficiency controlling parameters, e.g.,

photomultiplier high voltage or amplifier input sensitivity, from the value P to a new value P + ΔP, which is little different than the value P + ΔP′ for which the depression of the sample count rate would be exactly compensated. Once the relation between ΔP and ΔP′ is established, automatic compensation is possible. The procedure described also corrects for count rate changes due to color quenching, electronic gain changes, and changes in sample temperature. (auth)

14795 BEAM-LOSS DETECTOR BY COAXIAL REFLECTION IONIZATION CHAMBER (CRIC). Rosset, G. (CERN, Geneva). Nucl. Instrum. Methods, 60: 93-102(Feb. 1968).

The use of a long (120 m) gas-filled coaxial cable to monitor an inhomogeneous radiation field is described. A short high voltage pulse is applied to one end of the cable. Where ionizing radiation is present, the characteristic impedance is modified, and a partial reflection occurs. Time of arrival and amplitude of pulses received back at the source indicate location and relative strength of the radiation zones. (auth)

14796 NUCLEAR REACTION EFFICIENCY CORRECTION FOR SILICON AND GERMANIUM DETECTORS. Makino, M. Q. (Univ. of Southern California, Los Angeles); Waddell, C. N.; Eisberg, R. M. Nucl. Instrum. Methods, 60: 109-12(Feb. 1968). (USC-136-130).

The proton total-reaction cross section of silicon has been measured to be 732 ± 20 mb at 28 ± 1 MeV. The efficiency corrections for nuclear reactions in silicon and germanium detectors for protons from 5 to 150 MeV have been calculated using the energy dependence of the proton total-reaction cross sections. These calculations are shown to be in excellent agreement with direct measurements of the efficiency of silicon detectors. (auth)

14797 TECHNIQUE FOR DETERMINATION OF DEPLETION DEPTH IN Ge(Li) COUNTERS. Brownridge, J.; McLoughlin, D. (State Univ. of New York, Binghamton). Nucl. Instrum. Methods, 60: 116-20(Feb. 1968).

A method for determining the extent of the compensated region of p-type germanium drifted with lithium is described. It is a nondestructive method which is applied while the crystal is in the drifting apparatus and does not interrupt the drifting process. (auth)

14798 GAMMA SPECTROMETERS WITH GERMANIUM DETECTORS. Maslova, L. V.; Matveev, O. E.; Ryvkin, S. M.; Strokan, N. B.; Khusainov, A. Kh. pp 32-6 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966. (In Russian).
See STI/PUB-132.

The preparation of electrical contacts on Ge(Li) detectors is discussed. These contacts must be made very carefully in order to obtain high resolution and minimum detector noise. Also, a method for the fabrication of germanium detectors is described. It is based on the introduction of radiation defects in a germanium crystal. The advantage of these detectors compared with Ge(Li) detectors is in the fact that it is not necessary to store them at the temperature of liquid nitrogen. The characteristics of these radiation detectors are preserved during storage at room temperature. (auth)

14799 GERMANIUM FOR GAMMA-RAY DETECTORS. A REVIEW OF CURRENT PROBLEMS. Coleman, J. A. (NBS, Washington, D. C.). pp 37-41 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The performance of germanium gamma detectors depends, to a large extent, on the quality of the germanium used to produce the devices. The demand for better resolution, faster response times, and larger volume detectors imposes severe requirements on the germanium for detectors in terms of crystal purity and perfection. The specifications commonly used to describe germanium for detectors, such as resistivity, carrier lifetime, and etch pit density, were originally derived from those used by the semiconductor device industry. The relevance of these specifications for material to produce a detector with good performance, including long-term stability, is not well understood. A semiconductor detector requires extreme perfection throughout a large-volume single crystal. Such is not the case for common transistors and diodes which operate at much higher currents and noise levels and with much smaller volumes. The Electron Devices Section of the National Bureau of Standards is engaged in studies of the correlations between the properties of semiconductor materials and the performance of semiconductor devices fabricated from such material. The effects of carrier lifetimes and mobility and impurities such as oxygen, copper and gold in germanium on the performance and stability of gamma-ray detectors are being investigated. (auth)

14800 DEVELOPMENT AND APPLICATION OF LITHIUM-DRIFTED GERMANIUM DIODES AT THE ATOMIC ENERGY RESEARCH ESTABLISHMENT. Gibbons, P. E. (AERE, Harwell, Eng.). pp 42-55 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The fabrication of germanium detectors is described, and future developments are discussed. Also, cryostats and head amplifiers are briefly considered. Some applications of germanium diodes are outlined. (W.H.K.)

14801 LITHIUM-DRIFTED GERMANIUM DETECTORS AT THE LOS ALAMOS SCIENTIFIC LABORATORY: STATUS REPORT. Motz, H. T. (Los Alamos Scientific Lab., N. Mex.). pp 56-73 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The experimental facilities for studying thermal-neutron-capture gamma-ray spectra and the results of these measurements are described. With a resolution of about 4 keV at low energies and 8 keV at energies of 6 to 8 MeV, spectra of (n,γ) reactions from several elements have been observed. Coincidence measurements on (n,γ) reactions have been performed. Data gathered by the use of a 400 by 400 channel dual analogue-to-digital converter have been accumulated and analyzed on a high-speed computer. The complex radioactive decay spectra which comprise the decay products from thermal fission of ^{235}U have been studied. The Ge(Li) detectors have been used in radiochemistry, in the spatial observation of fission product inventory in irradiated fuel elements, and for other purposes. Results of these experiments are discussed. The fabrication of planar and coaxial detectors at Los Alamos Scientific Laboratory is described. (auth)

14802 FABRICATION AND USE OF LITHIUM-DRIFTED GERMANIUM DETECTORS. Kalbitzer, S. (Max Planck Institut fuer Kernphysik, Heidelberg). pp 133-41 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The preparation of Ge(Li) detectors by several techniques is described, including pulse drift, dc drift and ac drift. Results of drifing planar, radial and multiple structures are reported. The best resolution for ^{60}Co-gamma rays obtained was 3.0 keV, measured with our FET-preamplifier (uncooled). Fano factors of 0.20 to 0.25 were obtained in the energy range of 300 to 3000 keV. Some results concerning the reverse current of Ge(Li) detectors as a function of temperatures are given. (auth)

14803 MEASUREMENT OF SHORT NUCLEAR LIFETIMES WITH LITHIUM-DRIFTED GERMANIUM DETECTORS. Allen, K. W. (Oxford Univ., Eng.). pp 142-53 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The advantages of lithium-drifted germanium detectors for the measurement of short lifetimes by the Doppler shift attenuation and recoil distance methods are discussed. Examples are given of measurements made in ^{14}N and ^{18}F in the range 10^{-12} to 10^{-10} s. Gamma-ray line shapes are also briefly discussed. (auth)

14804 USE OF THE ACTIVATION METHOD TO DETERMINE FISSION NEUTRON SPECTRA THROUGH (n,γ) REACTIONS WITHOUT THRESHOLD. Mei, Ch'i-yung; Tai, Neng-hsiung; Sun, Han-ch'eng. Yuan Tzu Neng, No. 5, 350-2(1966). (In Chinese).

In continuing the study by Hu Hsuan-wen et al. (K'o chi, No. 4, 368(1964)), experiments are described on fission neutron energy spectra in the low-energy region by activating Au and Al foils through (n,γ) reactions without threshold energies. Neutron beams from the thermal column of a pile were directed to a target for fission neutron production. β-radioactivity of ^{198}Au and ^{27}Mg were determined after irradiation for 2 hr. Mean cross section ratios of fission neutrons from the reaction pair, $^{197}Au(n,\gamma)^{198}Au$ and $^{27}Al(n,p)^{27}Mg$, were determined to serve as indices with Maxwell distribution and standard ^{235}U fission spectra taken into account. Indices for ^{239}Pu fission neutron spectra were determined with respect to the weighted means of experimental data. Activity corrections were carefully made according to the following conditions: background induced by neutrons from the pile and by scattering of fission neutrons, geometrical factor resulting from foil location, and spectrum distortion caused by boron carbide. A curve showing the relationship between mean cross section ratio and energy spectrum parameter β was plotted according to the method employed by D. J. Hughes and Schwartz (Neutron Cross Sections Supplements, No. 1, to BNL-325, 2nd Ed.). Results ob-

tained were $\beta = 0.733 \pm 0.010$ for ^{239}Pu fission neutrons with corresponding $\bar{E}_{Pu^{239}} = 2.046 \pm 0.028$ MeV and $\bar{E}_{Pu^{239}}/\bar{E}_{U^{235}} = 1.055 \pm 0.014$. The results agree with those obtained by V. P. Kovalev, V. N. Anoreyev, et al. (ZhETF., 33: 1067(1957)). The (n,γ) reactions without threshold can be used in spectrum determination at low energies. (ATD)

14805 SURFACE-BARRIER COUNTERS OF ALPHA PARTICLES MADE OF P-TYPE Si. Maksimov, Yu. S.; Rodionov, Yu. F.; Yavlinskii, Yu. N. Fiz. Tekh. Poluprov., 1: 1039-42 (1967). (In Russian).

Surface-barrier counters were prepared from high-resistance ($\rho \sim 800$ ohm · cm) p-type Si. To create surface-barrier electron-hole junction, additional oxidation of the surface was realized in a vacuum chamber where a discharge was generated in an oxygen atmosphere. The stainless steel electrodes (45 mm in diameter and 6 mm in thickness) were placed ≈150 mm apart. The sample was placed on the lower electrode of the cathode (voltage, 400 V, current, 2×10^{-5} amp/cm^2, gas pressure, 0.05 to 0.1 mm Hg. The usefulness of the counter for α-spectrography was studied by using α-particles from ^{242}Cm, ^{241}Am, ^{239}Pu, and ^{233}U. The detector was placed in a chamber with a pressure of 10^{-3} mm Hg together with the α-particle source. The best energy resolution, 71 keV (1.3%), was obtained at a bias voltage of 8 V with a load resistance of 15M ohm. (ATD)

14806 ON THE CONDITION FOR THE FORMATION OF A THROUGH CONDUCTING CHANNEL IN HOMOGENEOUS CRYSTAL COUNTERS. Vitovskii, N. A.; Ryvkin, S. M. (Physical-Technical Inst., Leningrad). Fiz. Tekh. Poluprov., 1: 51-3 (1967). (In Russian).

This a continuation of earlier work (ZhETF., 28: 460(1956)) on CdS counters which the through conduction channel made quite sensitive to α particles. In view of the large scatter in the parameters of the CdS counters, due to the presence of uncontrollable impurities, the feasibility of using other materials, especially Ge and Si, is investigated. It is shown that high-amplitude pulses are produced if the counter material has a high resistivity and the lifetime of the nonequilibrium carriers is much larger than the time for establishment of diffusion drift equilibrium. The latter, in turn necessitates minimization of recombination and creation of barriers that prevent the minority-carrier drift, or production of impurities or defects capable of trapping the minority carriers. The number of such traps and the required trapping cross sections are estimated at 10^{16} to 10^{17} cm^{-3} and not less than 10^{-4} cm^2, respectively. While these values are realized in CdS and CdTe, they are difficult to attain in Si or Ge without greatly reducing the lifetime of the minority carriers. The introduction of barriers also raises difficulties. (ATD)

14807 MEASUREMENTS OF ^{238}U, ^{235}U, AND ^{237}Np CONTENT IN CYLINDRICAL IONIZATION CHAMBERS. Lie, Pao-hsing; Ku, Hung-k'un. Yuan Tzu Neng, No. 5, 346-9(1966). (In Chinese).

The content of fissionable materials in three kinds of cylindrical fission chambers was determined by measuring the number of α decays per unit time. The 4.4 mm-dia chambers contain 5-atm argon, 50 μ nickel bases, and electrodes with 1.38 cm^2 coatings of natural uranium, 90% enriched ^{235}U, and ^{237}Np, respectively. Essential components of the electronic circuit used include a 340-V power supply, a low-noise preamplifier, a nonoverdriven linear amplifier, a single-channel instrument, and scalers. Plateau characteristics of the single-channel instrument were determined to obtain α counting rates at a zero discrimination threshold, and the content of natural uranium, 90% ^{235}U, and ^{237}Np was calculated from the α counting rates. The α spectrum of an ^{237}Np coating, determined with a semiconductor detector and a 25-channel analyzer, was compared with that of impurity ^{239}Pu to show the ^{237}Np purity. The ^{237}Np and natural uranium content was calculated directly from the results of α counting rates, and the 90% ^{235}U content was determined indirectly by comparing α counting rates with those of a standard sample, because of the presence of an unknown amount of ^{234}U impurity. Calculation results were then corrected to remove effects of background values, self-absorption, backscattering, geometrical properties, and resolving time. The total errors were estimated to be ±2% for no. 105 and 114 ^{237}Np chambers and ±2.5% for both no. 101, 102, and 106 natural uranium chambers and for no. 103, 105, 107, and 108 90% ^{235}U chambers. Ratios of fission counting rates were also determined with a crystal spectrograph for four pairs of uranium chambers to complete verification tests. The tests were carried out under the action of the same thermal flux in the horizontal pipe of a heavy-water research reactor at the Chinese Academy of Sciences (Chung-kuo k'o hsueh yuan). It was concluded that the ratios of fission counting rates are comparable to those of ^{235}U contents with deviations lying within the error range. (ATD)

14808 BALLISTIC DEFICIT AND THE SIGNAL-TO-NOISE RATIO OF SEMICONDUCTOR SPECTROMETERS FOR ENERGY AND POSITION SPECTROSCOPY. Doehring, A.; Kalbitzer, S.; Melzer, W. (Max Planck Institut fuer Kenphysik, Heidelberg). Nucl. Instrum. Methods, 59: 40-4(Feb. 1968).

The ballistic deficit and the signal-to-noise ratio of one dimensional position-sensitive detectors are investigated by means of a simple model describing the detector as a line of a continuously distributed junction capacitance C and resistance R of the back layer. R has an upper limit, if the variation of the ballistic deficit for particles incident on different positions has been given a fixed value. On the other hand low values of the resistance of the back layer cannot be tolerated because of serious noise problems. Thus a compromise was found between these two conflicting aspects allowing a sufficiently small variation of the ballistic deficit and a reasonable resolution of the position and energy signal. In a typical case, e.g., C = 150 pF, R = 7.8 kΩ, equivalent noise resistance of the preamplifier $R_{eq} = 250$ ohm and using RC-integration and single delay line differentiation of 0.7 μsec, the variation of the ballistic deficit is less than 1%, the energy resolution 26 keV fwhm Si and the position resolution 44 keV fwhm Si. For a 50 mm long detector and 5.5 MeV particles the position resolution corresponds to 0.4 mm fwhm Si. (auth)

14809 ACCURATE DETERMINATION OF THE IONIZATION ENERGY IN SEMICONDUCTOR DETECTORS. Pehl, R. H.; Goulding, F. S.; Landis, D. A.; Lenzlinger, M. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 59: 45-55(Feb. 1968). (UCRL-17770).

The average energy ϵ expended for electron-hole pair generation in lithium-drifted silicon and lithium-drifted germanium detectors by gamma rays, electrons, and alpha particles is measured as a function of temperature. These data indicate that the difference between ϵ_α and ϵ_{e^-} in silicon is considerably less than previously reported, and in germanium $\epsilon_\alpha \sim \epsilon_{e^-}$. (auth)

14810 HIGH RESOLUTION SPHERICAL PROPORTIONAL COUNTER. Benjamin, P. W.; Kemshall, C. D.; Redfearn, J. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Instrum. Methods, 59: 77-85(Feb. 1968).

A compact proportional counter has been constructed with a spherical cathode and a thin wire anode along a diameter of the sphere. The electric field is made constant along the length of the anode by balancing the field variations due to the spherical cathode against those resulting from the presence of the wire supports. The resolution due to residual field distortion varies with gas multiplication and is 4.3% at a multiplication of 7 and 9.6% at a multiplication of 10,000. The response of the counter is not dependent on the direction of the radiation field to which it is exposed. (auth)

14811 A TWELVE INPUTS TIME-OF-FLIGHT CONVERTER FOR USE WITH A PDP-8 COMPUTER. Colombo, G.; Coppo, N. Stanchi, L. (EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 59: 86-90(Feb. 1968).

A time-of-flight converter designed for use with up to twelve detectors is described. The converter operates in connection with a PDP-8 computer and a special program allows to accumulate, print and display data. Interface problems are internally solved without the use of any additional equipment obtaining a more reliable system. The converter is constructed with monolithic integrated circuits and is contained in a quadruple ESONE plug-in-unit. (auth)

14812 DIGITAL SUPER-REGULATION OF AN ON-LINE TIME-OF-FLIGHT SYSTEM. Drobnis, D. D.; Lales, J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 59: 91-2 (Feb. 1968).

System gain and baseline drifts are monitored using events of known time, and the original time channel of each event corrected and rounded to an integer by a statistical process. (auth)

14813 FAST TIMING CIRCUIT FOR USE WITH CHERENKOV COUNTERS. Barna, A.; Richter, B. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 59: 141-5(Feb. 1968). (SLAC-PUB-254).

A timing circuit is described operating with Cherenkov counters of low light yield. Resolving times of 2 × 0.8 ns were measured with two counters, each producing an average of less than 5 collected photoelectrons. Light pulser measurements with 1000 photoelectrons yielded a resolving time of 2 × 70 ps. Design considerations, operating characteristics, and measurements with light pulser, with Cherenkov counters, and with the beam knockout system of the Stanford two-mile accelerator are discussed. (auth)

14814 NEW NEUTRON DETECTOR FILMS FROM POLYVINYL ALCOHOL. Napoli, C. (CNEN, CCR-EURATOM,

Ispra, Italy); Cortellessa, G. Nucl. Instrum. Methods, 59: 117-19 (Feb. 1968).

A method is described which makes it possible to obtain films of large size, easy to prepare, mechanically strong, rigid, insoluble in water, free from nuclei which will disturb experiments, and in which the quantity of detector element/cm^2 can be simply determined. This method has been applied so far to the preparation of films containing rare-earth elements, gold and sulfur. (auth)

14815 DETECTION OF FAST NEUTRONS WITH AN ORGANIC SCINTILLATOR: THEORETICAL AND EXPERIMENTAL STUDY OF THE DISTRIBUTION OF RECOIL PROTONS. Huck, A.; Walter, G. (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg, France). Nucl. Instrum. Methods, 59: 157-62 (Feb. 1968). (In French).

A method is described to represent the pulse height distribution resulting of recoil protons produced within an organic scintillator (stilbene) used as a monoenergetic ($E_n > 10$ MeV) neutron detector. Insensitivity to electrons and also to α particles originating from neutron-carbon interactions in the crystal is achieved by bidimensional pulse shape analysis of the fast and slow components of scintillation. In the proton energy range between 2.5 and 15 MeV the experimental spectrum obtained in this way is successfully compared with the calculated one. For the computation we take into account anisotropy of n-p scattering, escape of protons from the detector and nonlinear response of the scintillator. (auth)

14816 METHOD FOR AUTOMATIC COMPENSATION OF DEADTIME LOSSES. Seda, J. (Technical Univ., Prague). Nucl. Instrum. Methods, 59: 179-80 (Feb. 1968).

Deadtime in a radiation measuring apparatus can be corrected automatically and continuously by means of electronic circuits. A method of correcting the output counting rate by utilizing an auxiliary counting rate is described. (auth)

14817 URANIUM DETECTING MONITOR. Mes., Regul., Automat., 32: No. 3, 30 (March 1967). (In French).

A monitor for detecting atmospheric contamination by uranium dust for uranium processing plants is described. This instrument consists of four measuring channels which are scanned through a complete 30-minute cycle; samples are taken on each channel for 6 mn. Any excursion over a preset level of radioactivity triggers an alarm which can be telemetered, as also can the routine checks of the device. The measuring circuit consists of a semiconductor surface-barrier detector and a preamplifier, followed by an amplitude selector to eliminate natural radioactivity and counting scales. The measuring sequence is ensured by a photoelectric device, while the channels are mechanically switched electropneumatically. (auth)

14818 PERSONAL RADIATION MONITOR-BELT /Q2941/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1684).

18 drawings.

A Personal Radiation Monitor-Belt (PRM-B) is described which is designed to be worn clipped to the wearer's belt or shirt pocket. It is contained in a high-impact strength polystyrene case 3$^5/_8$ in. high, 2$^1/_4$ in. wide and 1$^1/_{16}$ in. thick. The instrument gives instant warning of the presence of radiation. The detector is a miniature Geiger-Mueller counter tube, sensitive to the intensity (dose rate) of γ rays and hard β particles. A screamer alarm (a hearing-aid type earphone with a resonant air column) makes a warning noise with pitch and repetition rate increasing as radiation intensity increases. Power is supplied by a 4V mercury battery with a battery life of ~ 10 mo. (For details see TID-4100 Suppl. 44.) (F.S.)

14819 CHARGE SENSITIVE PREAMPLIFIER TO RADIATION DETECTORS (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1667).

28 drawings.

A low noise charge sensitive FET input preamplifier is described which is used in improving the resolution in an ionization counter. The input is negative; the output is positive with 5V max into 50 Ω with better than 0.05% linearity; the gain is 0.024 V/MeV X1 and 0.046 V max X2 for argon gas; the pulse decay time constant is 500 μ sec; rise time is 450 n sec at 0 external capacitance and 250 n sec at 1000 pF external capacitance. (For details see TID-4100 Suppl. 43.) (F.S.)

14820 APPARATUS FOR MEASURING FISSION PRODUCTS. (to Gesellschaft fuer Kernfaschung, mbH). British Patent 1,100,434. Jan. 24, 1968. Priority date Feb. 21, 1964, Germany.

An apparatus for measuring fission products by the electrostatic separation of solid daughter nuclei of gaseous fission products is described. It consists of a precipitation vessel traversed by the carrier gas during measurement of radiation. The vessel contains a precipitation electrode and a radiation detector partially enclosed by the precipitation electrode. (W.H.K.)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 14637.

14821 (NP-17261) THERMAL NEUTRON SPECTRUM MEASUREMENTS AT A UTR-100 BEAM HOLE UTILISING A SLOW NEUTRON CHOPPER. Saldano-Vega, Juan Oscar; Scobie, J. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Sept. 1967. 39p. (SRRC-21/67). Dep.

A simple slow neutron chopper of the Fermi type has been constructed. Measurements have been made of the energy spectrum of neutrons in a beam coming from the thermal column of the UTR-100 reactor, with various arrangements of the internal graphite. (auth)

14822 (RISO-164) FIXED-SCATTERING-ANGLE SPECTROMETER FOR NEUTRON-DIFFRACTION STUDIES OF POWDERED SAMPLES. Lebech, B.; Mikke, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug. 1967. 45p. Dep.

A fixed-scattering-angle spectrometer for neutron-diffraction studies of powdered samples operating at the DR 3 reactor at Risö is described. Several typical results obtained using this instrument are presented, and for some of them a structure analysis is performed. As an example, the redetermination of the oxygen parameter for zinc oxide and the three parameters in $PbTiO_3$ is made. The experimental and theoretically computed resolutions are compared with the resolution of a typical fixed-wavelength spectrometer. Special features of the method and future applications are also briefly discussed. (DENM)

14823 (LA-tr-68-8) MEASUREMENT OF THE QUALITY FACTOR FOR HIGH-ENERGY NEUTRONS IN A TISSUE-EQUIVALENT PHANTOM. Zel'chinskii, M.; Komochkov, M. M.; Sychev, B. S.; Cherevatenko, A. P. (Joint inst. for Nuclear Research, Dubna (USSR)). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report JINR-P16-3587. 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Distribution of the dose rate and quality factor in a tissue-equivalent phantom bombarded with a neutron beam with a maximum spectrum energy of 700 MeV is investigated. The measurements were performed using a recombination ionization chamber. By comparing the value of the dose rate at a depth of 2.5 cm and that of the neutron flux ($E > 20$ MeV) the ratio $(8.6 \pm 2.1) \cdot 10^{-9}$ rad/n $\cdot$ cm^{-2} is obtained. (auth)

14824 Ge GAMMA-RAY SPECTROMETERS. Ridley, J. D. (Nuclear Enterprises, Winnipeg, Canada). Nucl. Eng., 13: 109-11 (Feb. 1968).

The principles and construction of Li-drifted Ge spectrometers are outlined, including the cryostat design and detector mounting. Low-noise preamplifier development is described, and the interpretation of the gamma spectra obtained is discussed. Applications of the spectrometers are reviewed. (UK)

14825 ANALYSIS OF RADIOACTIVE STANDARDS BY BETA SPECTROMETRY WITH SEMICONDUCTOR DETECTORS. Hareux, F.; Legrand, J. (CEN de Saclay, Gif-sur-Yvette, France). pp 681-90 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

Identification and determination of beta emitters in the impure state is essential for the accurate measurement of radioactive standards. The various types of detector used, and also the associated equipment, are analyzed and their performance is described. For some analyses the least-squares method is used; a number of examples are quoted (^{32}P, ^{35}S, ^{89}Sr, ^{90}Sr + ^{90}Y). In a more general study, Kurie representation of the spectra was used to identify and measure the beta emitters. ^{204}Tl, ^{36}Cl, ^{35}S, ^{14}C and ^{45}Ca were measured by this method. (auth)

14826 β AND X SPECTROMETRY WITH AN IONIZATION CHAMBER. Le Du, R. (Commissariat a l'Energie Atomique, Paris). pp 705-16 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

The spectrometer described is of cylindrical shape (length 50 cm, diameter 19 cm); it is acted on by an axial magnetic field (2500 oersteds) and operates by proportional ionization. The gas ($Ar-CH_4$) is continuously purified and kept at high pressure (1-15 kg/cm^2). The geometry is 4π, but a reduced solid angle can also

be used. The equipment can be used to study radionuclides emitting x or beta radiation in ranges from several tens of eV to 60 keV and 2 MeV, respectively. For the first time, as far as we know, it is possible to get a separating power very close to the theoretical separating power, even at high energies: for example, the half-height width is 13 keV for the ^{137}Cs 625-keV ray. Kurie lines have been drawn from the beta spectra obtained, and branching ratios have been measured as well as x-ray emission intensities for different radionuclides. The electronic circuitry used has special features (background, non-saturability, signal production). (auth)

14827 A DEVICE FOR PRECISE MEASUREMENTS OF RADIATION ENERGY FROM THE (n,γ) REACTION. Smirnov, A. I.; Shaburov, V. A.; Alexeyev, V. L.; Kaminker, D. M.; Rylinkov, A. S.; Sumbayev, O. I. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 60: 103-8(Feb. 1968).

A precision angle measuring device for a Cauchois spectrometer with scintillation recording of gamma-quanta designed for studies on thermal neutron capture gamma radiation is described. The Bragg angles are measured by means of a sine screw mechanism with a 1 m long lever arm. Relative accuracy of the energy measurements is about 2.5×10^{-5} within 50 to 500 keV and some 1×10^{-4} over the range 500 keV to 1 MeV, the errors being about 0.5 eV at 50 keV and 100 eV at 1 MeV. To check the operation of the device, strong lines following neutron capture by ^{45}Sc nuclei were studied. The spectrometer is mounted on the BBP-M reactor radial horizontal channel at the A. F. Ioffe Physical-Technical Institute. (auth)

14828 STUDY OF NEUTRON RESONANCE PARAMETERS USING SLOWING DOWN TIME LEAD SPECTROMETER. Navalkar, M. P.; Chandromoleshwar, K.; Ramkrishna, D. V. S. (Bhabha Atomic Research Centre, Trombay, India). Nucl. Instrum. Methods, 60: 113-15(Feb. 1968).

A slowing-down-time lead spectrometer set up at Trombay has been used for the measurement of neutron resonance parameters. The measurements have been carried out using capture gamma rays from samples of Ag, Au, Ta, and Ho and the area method of analysis is adopted to evaluate the resonance parameters. The results have been compared with published BNL-values and show good agreement within experimental errors, thereby verifying that the lead spectrometer can also be used in the low energy region (below 5 eV) for such measurements. (auth)

14829 COAXIAL LITHIUM-DRIFTED GERMANIUM DIODES FOR GAMMA-RAY SPECTROSCOPY. FABRICATION AND CHARACTERISTICS. Tavendale, A. J. (Australian Atomic Energy Commission, Sydney). pp 4-28 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

Lithium-drifted germanium p-i-n diodes have been fabricated using the coaxial configuration and their diode and γ-ray spectrometer characteristics have been investigated at liquid nitrogen temperatures (77°K). A simple technique is described, which has been used to drift diodes with volumes up to 66 cm^3 (19.5-d drift period). Ga-doped horizontal zone-leveled germanium crystals with (1,1,1) orientation and resistivity in the range of 10 to 22 ohm-cm were used. Problems encountered in the lithium drift phase of diode fabrication caused by crystalline imperfection of the base material are discussed. Drift data, diode dc conditions for best spectrometer operation and experimental resolutions for ^{57,60}Co-source γ rays are tabulated for four coaxial Ge(Li) detectors 14.5-40 cm^3 active volume, and other sections taken from these. Spectral responses to γ rays up to 17-MeV are presented. Resolutions (fwhm) of 1.47, 3.85 and 8.3 keV on the full-energy peaks of 122, 1173 and 2754 keV γ rays have been obtained from a 22-cm^3 detector using a cooled field effect transistor input stage preamplifier. The construction of coaxial Ge(Li) diodes with guard rings for high-bias operation is discussed and the operation of one such device is demonstrated. (auth)

14830 TECHNIQUES EMPLOYED IN THE FABRICATION OF GERMANIUM GAMMA-RAY SPECTROMETERS. Ridley, J. D. (Oxford Univ., Eng.). pp 29-31 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

The technique of fabrication of planar and coaxial Ge(Li) detectors at Nuclear Physics Laboratory, University of Oxford is described. U-shaped counters with no insensitive region, small pulse-time spread, and low capacity have been prepared. The choice of material, the details of drifting and clean-up procedure, and the difficulties in detector fabrication are presented. The auxiliary equipment needed for the high-resolution gamma spectrometers with Ge(Li) detectors and the characteristics of these spectrometers are described. (auth)

14831 MEASUREMENTS WITH LITHIUM-DRIFTED GERMANIUM DETECTORS AT BROOKHAVEN NATIONAL LABORATORY. Chasman, C. (Brookhaven National Lab., Upton, N. Y.). pp 74-89 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

Lithium-drifted germanium detectors have been used at BNL for studies of the gamma rays from radionuclei, slow neutron capture at the graphite reactor, and particle reactions at the 3-MeV electrostatic accelerator. Measurements performed, that are directly related to nuclear physics, include precise energy determination, branching ratios, conversion coefficients, and lifetimes by the Doppler shift method. However, these detectors have also been used to examine the x-rays from the μ-mesic atoms, the ratio of the energy loss by electronic excitation to atomic collisions of a germanium ion in a germanium lattice and the composition of trace elements in ancient glass. A computer program that finds gamma-ray peaks, makes a least-squares fit to the spectrum, and calculates peak centroids has been developed and found exceedingly useful in data handling. Typical experiments characterizing the various measurements performed utilizing the different facilities at Brookhaven are described. (auth)

14832 LITHIUM-DRIFTED GERMANIUM DIODES IN NEUTRON-CAPTURE GAMMA-RAY SPECTROSCOPY. Michaelis, W.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 90-101 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

The investigation of neutron-capture gamma-ray spectra is a promising way to get information on multiple phonon states in spherical nuclei and for a detailed understanding of the level structure of deformed nuclei. The Ge(Li) detector has proved to be an important instrument for the analysis of the very complex spectra. A summary of the research done at Karlsruhe with these detectors is given and the results obtained are discussed. It was found that the precision which can be obtained is limited by factors that are largely related to the characteristics of the electronic elements used. The precautions that were made at Karlsruhe to perform precision measurements are described and some future trends in the application of Ge(Li) detectors are discussed. (auth)

14833 LITHIUM-DRIFTED GERMANIUM GAMMA-RAY SPECTROMETERS AT CHALK RIVER. SOME RECENT WORK. Ewan, G. T.; Malm, H. L.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ontario). pp 102-32 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

A review is given of some recent work with Ge(Li) detectors at Chalk River. The development and properties of large-volume coaxial detectors are discussed briefly. Typical results of measurements of the resolution, efficiency and peak-to-total ratios for these detectors are presented. Results of performance tests on encapsulated detectors are summarized. Some of the factors affecting the pulse shape from Ge(Li) detectors are considered and time distribution measurements from coaxial detectors are shown. These detectors are being used in a Ge(Li)-Ge(Li) γ-γ coincidence arrangement and typical results are given. The use of the detectors in the experimental program at Chalk River is discussed briefly, with results from a few experiments chosen to illustrate their different applications. These include their use in experiments on nuclear decay schemes, γ-rays from nuclear reactions, neutron-capture γ rays, resonance γ-ray scattering, muonic x rays, and experiments associated with nuclear reactor development. (auth)

14834 RESONANCE NEUTRON CAPTURE WITH LITHIUM-DRIFTED GERMANIUM DETECTORS. Jackson, H. E.; Julien, J.; Samour, C.; Chevillon, P. L.; Morgenstern, J.; Netter, F. (Centre d'Etudes Nucleaires de Saclay, France). pp 154-62 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.

See STI/PUB-132.

A program of high-resolution studies of resonance neutron-capture spectra of complex nuclei is currently in progress with the Saclay electron linac as the neutron source. The data yield information on general characteristics of nuclear structure such as the energy dependence of partial radiation widths, specific details of nuclear level schemes, and systematics of neutron capture. The first case studied, Pt (n,γ), demonstrates the value of such experiments. The capture spectra for about 30 resonances have been studied with a Ge(Li) detector whose sensitive volume was 7 cm^3. In ^{196}Pt 16 new primary transition feeding states within 2.8 MeV of the ground state of ^{196}Pt are found. The failure to observe a significant transition to the state at 1117 keV indi-

cates that either the established level scheme of ^{196}Pt is in error or a serious deviation from the usual "single particle" estimate of the partial widths has been observed. In addition, an analysis has been performed to determine the statistical properties of the first three primary transitions. (auth)

14835 SPECTROSCOPY OF MESONIC ATOMS. Nilsson, S. (CERN, Geneva). pp 163-84 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

The introduction of Ge(Li) detectors has permitted an improvement of energy resolution on muonic x-ray spectra by one order of magnitude. At the muon channel of the 600-MeV synchrocyclotron, x-ray spectra have been studied for 19 spherical nuclei between Z = 17 and Z = 83. Also many deformed nuclei have been investigated. The radial parameters C and surface thickness parameters t of the Fermi-type charge distributions have been determined and compared with electron scattering data. Also hyperfine structure, isotope and nuclear polarization effects have been studied. The Ge(Li) detector having an area of 3.5 cm^2 and a thickness of 6 mm was made at the University of Basel. It was used in coincidence with a counter telescope for the muons. The Ge(Li) had to be placed directly in the beam in order to make the solid angle as large as possible. Some difficulties appeared with gain drift at high counting rates. Typical running times for each sample were 3 to 5 hr. Results of these experiments and also some preliminary information on π-mesic x rays are presented. (auth)

14836 NEUTRON- AND PROTON-CAPTURE GAMMAS MEASURED WITH LITHIUM-DRIFTED GERMANIUM SPECTROMETERS. Arnell, S. E.; Hardell, R.; Hasselgren, A.; Jonsson, L.; Skeppstedt, O. (Chalmers Univ. of Tech., Goteborg). pp 185-210 of Lithium-Drifted Germanium Detectors. Vienna, International Atomic Energy Agency, 1966.
See STI/PUB-132.

Ge(Li) detectors with volumes of 0.56 and 2 cm^3 have been used in nuclear structure studies by means of neutron- and proton-capture reactions. Due to the relatively small dimensions of the detectors available it has appeared to be of importance to simplify the response functions for gamma radiation of energy higher than a few hundred keV. For high energy gammas the introduction of a bisected annulus of NaI for the detection of annihilation radiation in a pair spectrometer arrangement increases the signal-to-background ratio considerably. The loss in statistics is more than compensated for and possible ambiguities in the interpretation of the spectrum are removed. For gamma radiation in the energy region 0.5 to 3 MeV the response function of a small detector is complex. The Compton distribution can be reduced and smoothed by the use of anticoincidence arrangements. Experiences gained from different types of measurements are discussed. (auth)

14837 CHOPPER WITH TYPICAL CURVED SLITS AS MONOCHROMATOR FOR COLD NEUTRONS. Demichelis, F.; Rasetti, M.; Vadacchino, M. (Istituto di Fisica Sperimentale del Politecnico, Turin). Nucl. Instrum. Methods, 59: 136-40 (Feb. 1968).

The behavior of a curved slits chopper-monochromator was examined. The neutron path in a coordinate system rotating with a Fermi chopper is determined without any restriction on the incidence angle and on the angle of rotation of the chopper while neutrons are passing through it. All possible neutron-paths having velocities included in a given range, when velocity resolution and angle ϕ_{te} difference between the anomalies at the entrance and at the exit of the neutron from the chopper are predetermined, were calculated for some cases. The extreme paths determine the profile of the slits. An acceptance angle is also determined for the various cases. The chopper-monochromator is simultaneously capable of high resolution and sufficiently good transmission. (auth)

14838 USE OF A POSITION-SENSITIVE SOLID STATE DETECTOR TO MEASURE PROPERTIES OF A MAGNETIC SPECTROMETER. Elliott, R. V.; Carter, K. W.; Spear, R. H. (Australian National Univ., Canberra). Nucl. Instrum. Methods, 59: 29-39 (Feb. 1968).

A technique based upon the use of a position-sensitive solid state detector was developed for measuring properties of a 61 cm double focussing magnetic spectrometer. It has proved particularly convenient for determining the position of the focal plane. (auth)

14839 METHOD OF TIME CALIBRATION FOR TIME-OF-FLIGHT EXPERIMENTS IN NUCLEAR PHYSICS. Langsford, A.; Dolley, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 59: 120-4 (Feb. 1968). (AERE-R-5381).

A unit for producing calibration points for time-of-flight systems is described. Not only is this device free of some of the obvious problems of time calibration techniques but also it provides a powerful diagnostic tool for determining timing uncertainties and non linearities in a system. The minimum interval between calibration points can be as small as 25 nsec, and the unit will operate at rates exceeding 10 kHz. (auth)

14840 SECOND AND HIGHER ORDER NUMERICAL CALCULATIONS FOR A SPECTROMETER WITH WINDING MAGNETIC FIELD. Tauscher, L.; Daniel, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg. CERN, Geneva). Nucl. Instrum. Methods, 59: 109-16 (Feb. 1968). (In German).

Higher order calculations have been performed for a recently proposed high dispersion β-ray spectrometer with a winding magnetic field. It is shown that the radial aberration terms of φ_r^2 and φ_r^2 simultaneously vanish by a suitable choice of the second field coefficient a_2 and the slope k. In the third, fourth and fifth order approximation a focusing independent of φ_r can be achieved. With a focusing angle of 909.72° and a focusing independent of φ_r^2 and up to the fifth order independent of φ_r, the intensity distributions of point sources at the image plane are calculated. It is shown that, using spark chambers with infinite resolution at the source and detector planes, the resolution depends on the position of the point source, but, for a wide range of source coordinates, is always $\Delta p/p < 2 \times 10^{-3}$. In the usual case of β-ray spectroscopy with exit slit the resolution is found to be better than that for corresponding flat spectrometers. (auth)

14841 A DEVICE FOR STUDYING MOESSBAUER EFFECT. Zhetbaev, A. K.; Kaipov, D. K.; Smirin, L. N.; Tyshchenko, A. P.; Kadykenov, M. M. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 18-23 (Mar.-Apr. 1967). (In Russian).

The system consisted of three parts: a source connected to an electrodynamic vibrator, a proportional counter filled with a xenon-isopentane mixture and a control system for automatically recording the data. The maximum velocity of the moving source was V_{max} = 1 cm/sec at a frequency of 3 cycles/sec and a coil voltage of 100 volts. The velocity stability and linearity were better than ±1%. Measurements could be carried out over a period of many hours due to the high mechanical stability of the unit. The resolution of the proportional counter was about 12% at 14.4 keV, which is much better than the resolution of a scintillation counter at these low energies. (TTT)

14842 PULSE SHAPING VARIABLE GAIN AMPLIFIER (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1668).
35 drawings.

A moderate gain, versatile pulse amplifier is described which is used in high resolution α spectroscopy at moderate counting rates and in germanium detector γ spectroscopy systems at moderate rates. Six choices each of low and high pass pulse shaping networks permit optimization for different preamp detector combinations. Pole-zero cancellation and base line restoration for improved performance in the 500 to 5000 cps range are utilized. Good resolution in 5000 to 30,000 cps range is obtained with a component change. The amplifier is contained in a NIM module, for use in a standard NIM bin with a power supply. The power supply is rated at ±24 V at 50 mA. Gain is adjustable in 5 steps from 2 to 64 in DL or equal RC modes. Pulse shaping in high pass networks-delay line and 5 RC modes is 1.0, 1.8, 3.3, 5.6, and 10.0 μsec; in low pass networks 6 RC modes it is 0.1, 1.0, 1.8, 3.3, 5.6, and 10.0 μsec. Noise is less than 20 μV at input. (For details see TID-4100 Suppl. 43.) (F.S.)

14843 METHOD AND APPARATUS FOR AUTOMATIC STANDARDIZATION IN LIQUID SCINTILLATION SPECTROMETRY. (to Packard Instrument Co., Inc.). British Patent 1,100,931. Jan. 24, 1968. Priority date June 18, 1964, United States.

An apparatus for liquid scintillation spectroscopic analysis of radioactive samples is described. Included in the design is a means for introducing a standardized radiation source in conjunction with the sample being analyzed. This allows for automatic calibration of the spectra. (W.H.K.)

High Energy Physics Instrumentation

Refer also to abstracts 15659 and 15693.

14844 (AERE-R-5008) MAGNETIC TAPE STORE. Hunt, R. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1965. 13p. Dep. CFSTI. UK.

A Magnetic Tape Store is described which forms part of a data handling system for use with spark chambers. The store will accept a block of 256 words each 16 bits in less than 18 milliseconds and up to 16000 such blocks may be stored on a standard tape. (auth) (UK)

14845 CHARACTERISTICS OF ELECTRICAL BREAKDOWN ALONG PARTICLE TRAJECTORIES IN A WIDE GAP SPARK CHAMBER. Caris, L.; Kuiper, B.; Williams, E. M. (CERN, Geneva). Nucl. Instrum. Methods, 59: 145-51(Feb. 1968).

An experimental investigation is described of the phenomena of electrical breakdown along particle trajectories in a wide gap spark chamber. Data are presented for the spark formation time and the development of the spark is discussed in terms of measurements of the growth of luminescence as observed with a photomultiplier. (auth)

Radiation Dosimeters

Refer also to abstracts 14756, 15003, and 15412.

14846 (AED-C-21-04) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 21. DOSIMETRY. Becker, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Oct. 1967. 74p. (In several languages). Dep.

One hundred and ninety-six references on conference papers are presented on various aspects of radiation dosimeters and radiation dosimetry. Author, report number, and subject indexes are included. (B.G.D.)

14847 (AED-C-21-05) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 21. DOSIMETRY. Becker, K. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Aug. 1967. 74p. (In several languages). Dep.

Two hundred and forty-three references on dissertations, patents, and reports are presented on various aspects of radiation dosimeters and radiation dosimetry. Author, report number, and subject indexes are included. A list of the various bibliographies published by the Zentralstelle fuer Atomkernenergie Dokumentation is provided. (B.G.D.)

14848 (AERE-M-1763) CALIBRATION RIG FOR GAMMA RADIATION DOSE-RATE METERS. Stephenson, J. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1967. 35p. Dep. CFSTI. UK 8s. 0d.

The design, operation, and performance of a calibration device for the routine testing and calibration of gamma radiation dose-rate meters in use at AERE, Harwell, is described. The test and calibration schedules for these instruments are given and the record keeping system is described. (auth)

14849 (BNWL-SA-1575) METHOD OF QUANTITATIVE THERMOLUMINESCENCE. Watson, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 4, 1968. Contract AT(45-1)-1830. 3p. (CONF-671121-2). Dep. CFSTI.

From Conference on Interdisciplinary Discussion of Solid State Dosimetry, Seattle, Wash.

A method is described which allows simultaneous recording of the thermoluminescent glow curve and the integral under any specific peak. The mechanical integrator employed, attached to a strip chart recorder, is inexpensive and reliable. (auth)

14850 (HASL-191) INVESTIGATION OF THE LiF TLD SYSTEM FOR LOW EXPOSURES. Shambon, A. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Dec. 1967. 12p. Dep. CFSTI.

Various problems connected with the use of a commercial LiF dosimetry system for low radiation exposure measurements were investigated. These are adsorption of moisture, its effect on dispensing LiF powder, the consistency of readouts, the relation between capsule size, and sensitivity of LiF powder in Bonner spectrometry. Moisture adsorption was found to be negligible, readout inconsistencies were eliminated by modification of readout instrumentation, sensitivity was shown to increase with decrease in capsule diameter when exposure was to thermalized neutrons. To eliminate some of the disadvantages associated with the handling of powder, a LiF pellet dosimeter was developed. This pellet consists of 50 mg LiF powder combined with 2 mg sodium silicate by means of a cold pressing process. It gives good linear reproducible response to exposures from 11 mR to 150 R. The pellet is small, easily made, and inexpensive. (auth)

14851 (STI/PUB-138) SOLID STATE AND CHEMICAL RADIATION DOSIMETRY IN MEDICINE AND BIOLOGY. Proceedings Series. Proceedings of a Symposium held in Vienna, 3-7 October 1966. (International Atomic Energy Agency, Vienna (Austria)). 1967. 481p. (CONF-661005). IAEA: $10.00; Austrian Schillings 259,-; £ 3.10.8; F Fr 49,-; DM 40,-.

Separate abstracts were prepared for 11 of 35 papers presented. Twenty-four papers were previously included in NSA. For abstracts of these papers see CONF-661005 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 14786 and 14855-14864.

14852 (STI/PUB-21/23) SOLID-STATE DOSIMETRY. Bibliographical Series No. 23. (International Atomic Energy Agency, Vienna (Austria)). 1967. 143p. IAEA: $3.00; Austrian Schillings 78,-; Pound 1.1.2; F Fr 14,70; DM 12,-.

Seven hundred and fifty-four references are presented on various aspects of solid-state dosimetry. Author and keyword indexes are included. (B.G.D.)

14853 (UCRL-70860) A SEMI-AUTOMATED THERMOLUMINESCENT DOSIMETER READER. Petrock, K. F.; Jones, D. E. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1968. Contract W-7405-eng-48. 18p. (CONF-680302-2). Dep. CFSTI.

For Presentation at International Symposium on Nuclear Electronics and Radioprotection, Toulouse, France.

An improved thermoluminescent dosimeter (TLD) reader is described with principle features of unattended readout of 80 TLD's after manual loading, heating of the TLD's with hot nitrogen gas, and versatile electronics that allow simultaneous readout of the glow curve and integrated light output. A prototype unit reads 80 extruded LiF rods over a dynamic range of 3 mR to 300 R in 40 minutes. Digital light output and glow curves suitable for computer analysis have been produced with the reader. Current improvements should increase the dynamic range at least an order of magnitude and higher doses can be read by filtering the light output or lowering the photomultiplier tube voltage. Planned modifications will be discussed. (auth)

14854 LiF AND CaF_2:Mn THERMOLUMINESCENT DOSIMETERS IN TANDEM. Gorbics, S. G.; Attix, F. H. (Naval Research Lab., Washington, D. C.). Int. J. Appl. Radiat. Isotop., 19: 81-9(Feb. 1968).

Thermoluminescent dosimeters employing two or more different phosphors can be used for measuring the dose from different components of a radiation field. In particular, two phosphors of differing atomic numbers can be utilized to measure the effective energy of an x- or γ-ray field. If their glow-peak temperatures differ sufficiently, or if a time delay can be applied to the heating of one or the other phosphor, their thermoluminescence signals can be separately measured in a single heating operation. The resulting combined glow curve indicates, in peak height or area of either glow-peak, the dose or exposure reading. The ratio of peak heights (or areas) yields the effective energy. Such a tandem dosimeter, employing extruded LiF (TLD-700) and hot-pressed CaF_2 : Mn, was constructed and its performance explored. (auth)

14855 RECENT DEVELOPMENTS IN THERMOLUMINESCENT DOSIMETRY; EXTENSIONS IN THE RANGE OF APPLICATIONS. Brooke, C.; Schayes, R. (Manufacture Belge de Lampes et de Materiel Electronique, Brussels). pp 31-50 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

An operational thermoluminescent dosimetry system, in which the phosphor is bonded to the cathode of a miniature radio tube, is briefly described and the main characteristics summarized, including energy response. The system is capable of many developments extending the range of use. These include: the measurement of very low doses from a few tens of microroentgens upwards, the possibility of multiple readings through a light transfer phenomenon, and in some natural fluorites the glow curve is markedly dependent on the type of irradiation. (auth)

14856 STUDIES ON THERMOLUMINESCENT LITHIUM BORATE FOR DOSIMETRY. Kirk, R. D.; Schulman, J. H.; West, E. J.; Nash, A. E. (Naval Research Lab., Washington, D. C.). pp 91-5 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

Continued studies of the preparation of manganese-activated lithium borate have shown that it can be made reproducible in batches of the order of 75 g. The properties of these preparations are not the same as those of the 15-g preparations made from the same starting compositions. The larger-scale preparations have greater sensitivity and/or greater supralinearity than the small batches. The supralinearity has been found to be related to a radiation-induced creation of traps which have a glow peak temperature that is about 20°C higher than that of the deep traps native to the phosphor as prepared. Initial attempts are described to

exploit this trap creation to achieve increased sensitivity and linearity of response. (auth)

14857 PROPERTIES OF AN ENAMEL-COATED CaF_2:Mn THERMOLUMINESCENT DOSIMETER. Mihailovic, M. (Univ. of Ljubljana, Yugoslavia). pp 107-113 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

The good properties of the CaF_2: Mn thermoluminscent powder for radiation dosimetry have been conserved by coating the powder with enamel. Special enamels were developed to prevent chemical and mechanical influences of the enamel components to the CaF_2: Mn. A very small dosimeter, simple in construction, robust and practically unbreakable, has been developed. The thermoluminescent material, consisting of CaF_2: Mn powder and the enamels is more sensitive than the CaF_2: Mn powder itself. Fading of the dose with time allows simple determination of the dose. The fading occurs in the first two days after irradiation and after that is of the order of 0.2% per day. Sensitivity of a small version of the dosimeter is from 20 mR to 10^4 R of ^{60}Co gamma radiation. A 1.2 mm Pb filter with a hole makes the dosimeter energy independent in the energy range from 26 keV_{eff} to 1.25 MeV. (auth)

14858 PROPERTIES OF SOLID STATE DOSIMETERS AND THEIR USE IN MEDICINE. Regulla, D.; Pychlau, H.; Wachsmann, F. (Gesellschaft fuer Strahlenforschung mbH, Nuremberg). pp 121-7 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

The advantages of solid state dosimeters are described, and they are compared with ionization chambers; some results are reported regarding new measurements made on metaphosphate glasses and thermoluminescence dosimeters. In particular, problems such as sensitivity, energy dependence, accuracy, and repeated use are discussed. Different glasses, and even more different thermoluminescent substances, show wide oscillations in their behavior, depending on the method of melting and pretreatment. Practical experience in the use of metaphosphate glasses and thermoluminescence dosimeters for measurements of dose distribution of conventional and ^{60}Co radiation in phantoms for the purposes of radiotherapy is described. (auth)

14859 USE OF PHOSPHATE GLASSES FOR DOSIMETRY OF MIXED RADIATION FIELDS IN NEUTRON RADIOBIOLOGY. Maushart, R.; Piesch, E. (Karlsruhe Nuclear Research Centre, Ger.). pp 157-65 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

In many cases phosphate glasses are well suited to determine the γ dose in various organs of the body for radiobiological purposes. The gamma- or X-ray-dose value is measured after proper calibration by measurement of the fluorescent light. It is also possible to measure the neutron-induced radioactivity of the glasses after neutron irradiation, thus making the glass dosimeters useful tools for simultaneous determination of gamma and neutron doses. The fields of use and the limits of this method, for different irradiation conditions, are described in this paper. (auth)

14860 PHOTOVOLTAIC EFFECT OF X OR GAMMA RAYS IN p-n JUNCTIONS WITH SURFACE BARRIER: APPLICATION TO DOSIMETRY. Blanc, D. (Univ., Toulouse); Casanovas, J.; Peyre-Lavigne, A.; Chapuis, Anne-Marie; Soudain, G. pp 185-91 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

The detection procedure consists in measuring the non-equilibrium photocurrent, which is composed of two counter-directed currents, the migration current of the pairs in the depletion zone and the diffusion current of the minority carriers entering the zone of sensitivity. The procedure was used for x-ray (from 20 to 250 keV) and gamma-ray (~1 MeV) dosimetry. The relation between the short-circuit current and the dose-rate was determined by means of Victoreen ionization chambers. The response characteristics of the junctions are described. In the case of the x rays that were studied, the intensity of the photocurrent was analyzed in detail. The photoelectrons are emitted in a cone with a half-angle of between 50 and 90° at the vertex, so that the diffusion of the minority carriers is non-isotropic. The transport equation involves a source term which has been calculated for the various regions of the diode. This calculation makes use of slowing-down theory, as well as Shockley and Read's recombination model. It also takes into account the attenuation of the incident beam and the boundary conditions corresponding to the surface state of the semiconductor. These equations do not involve the diffused photons which are to be found in the case of gamma rays with an energy in the neighborhood of 1 MeV. (auth)

14861 STANDARDS AND QUANTITIES IN RADIATION DOSIMETRY. Wyckoff, H. O. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). pp 333-45 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

The International Commission on Radiation Units and Measurements (ICRU) has defined the quantities needed for medical and biological dosimetry of x rays, gamma rays, and electrons. It has also suggested a method for obtaining the absorbed dose at the point of interest. This material is reviewed and some consideration given to the needs for standards in the higher-energy x-ray and electron field. (auth)

14862 METHODS OF ABSORBED-DOSE MEASUREMENT. Boag, J. W. (Inst. of Cancer Research, Sutton, Eng.). pp 349-66 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

There are today many methods of measuring absorbed dose, and which method to use depends upon the nature of the problem. The important criteria are discussed, and the field of application of different methods is illustrated by tables and diagrams. Only the calorimetric and ionization methods of absorbed-dose measurement can be considered to provide absolute measurement but chemical methods and some solid state methods may be equally accurate. The newer solid state methods have proved particularly suitable for special problems, such as the storage of dose information, use in very confined spaces, or the measurement of extremely low or extremely high doses or dose-rates. However, the established ionization methods must not be abandoned. (auth)

14863 IONIZATION CHAMBER FILLED WITH A TISSUE-EQUIVALENT LIQUID FOR THE DOSIMETRY OF ELECTROMAGNETIC RADIATIONS. Blanc, D. (Univ., Toulouse); Mathieu, J.; Patau, J. P.; Francois, H.; Soudain, G. pp 371-9 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967. (In French).

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

Ionization chambers with coaxial cylindrical electrodes filled with a dielectric liquid constitute a means of dosimetry which is both sensitive and stable in respect to time, provided the liquid is carefully purified and the chamber is filled under clearly determined experimental conditions. A mixture of carbon tetrachloride (4% in volume) and ordinary hexane (96% in volume) is used. This can be regarded as equivalent to soft biological tissue, the ratio of its mass coefficient for energy absorption to that of soft tissue remaining constant, at 1.045, for photons in the 30 keV-5 MeV energy band. For an applied voltage of 5000 V, the ionization current is proportional to the fluence over a range from 5×10^{-7} rad/s up to 1 rad/s. Calibration was performed using ^{60}Co and ^{137}Cs sources by means of filtered x-ray beams of approximately 200 keV, 160 keV, 115 keV and 70 keV. This dosimeter can be used both for fast-neutron dosimetry and for measuring mixed fields of neutrons and gamma radiation; in the latter case, it can be used to obtain the absorbed dose from each of the two constituents. (auth)

14864 SEMICONDUCTOR ELECTRICAL CONDUCTIVITY DETECTORS. Parker, R. P. (Inst. of Cancer Research, Sutton, Eng.). pp 437-44 of Solid State and Chemical Radiation Dosimetry in Medicine and Biology. Vienna, International Atomic Energy Agency, 1967.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna. See STI/PUB-138; CONF-661005.

A solid state analog of the gaseous ionization chamber is attractive, particularly due to the resulting increase in sensitivity. The basic physical principles underlying such devices are examined, and methods by which practical difficulties have been overcome are described. Attention is paid to recent developments, particularly in respect to detectors possessing internal amplification. The possible use of semiconductor electrical conductivity detectors as absolute dosimeters is considered. (auth)

14865 DOSIMETRY BY ACTIVATION DETECTORS IN PHANTOMS SUBJECTED TO HIGH-ENERGY PROTON IRRADIATION. Sklavenitis, L. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 59: 73-6(Feb. 1968). (In French).

In spite of intrinsic difficulties a group of activation detectors were used to analyze fluxes within a paraffin phantom submitted to a homogeneous 3 GeV proton beam and to reproduce absorbed doses independently measured by ionization chambers. Using already existing calculations concerning absorbed doses due to heavy particles produced by nuclear reactions in the 100 to 400 MeV energy region an approximate estimation of the corresponding dose equivalents and quality factors were attempted. (auth)

14866 INFLUENCE OF TEMPERATURE ON THE KINETICS OF THE GAMMA CONDUCTIVITY OF CADMIUM SULFIDE. Litovchenko, P. G.; Konozenko, I. D.; Ust'yanov, V. I. (Inst. of Physics, Kiev). Fiz. Tekh. Poluprov., 1: 491-4(1967). (In Russian).

This is a continuation of earlier work (FTT v. 4, 1689, 1962) dealing with the relaxation of γ conductivity in CdS crystals used for γ dosimetry. The present investigations were made with illumination at a wavelength 547 nm, which lies beyond the intrinsic-absorption edge of the CdS. The procedure and experimental techniques were the same as in the earlier work, and the experiments were carried out in such a way that a γ radiation pulse was applied against the background of continuous light flux. A study of the kinetic excitation curves of the γ current in the illuminated crystal, carried out at temperatures 100–320K, shows that with increasing illumination intensity the γ-current variation is the same as observed before at room temperature, namely that an increase in the light intensity decreases the inertia and enables the nonequilibrium conductivity to reach its stationary value more rapidly. Plots of the characteristic relaxation times of the γ current against the temperature have revealed the presence of maxima which are determined by the positions of the adhesion levels. A theoretical analysis of the variation of the characteristic time as a function of the temperature shows that this dependence has a maximum when the Fermi quasilevel goes through the adhesion level, in agreement with the experimental data. As a result, a new method is proposed for determining the depths of the adhesion level from the study of the temperature dependence of the kinetics of γ conductivity or photoconductivity at low excitation energy. (ATD)

Radiometric Instruments

14867 (AWRE-O-2/65) GAUGE FOR THE MEASUREMENT OF THE THICKNESS OF NICKEL PLATING ON URANIUM. Godward, D. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Mar. 1965. 18p. Dep. CFSTI. UK.

The method of measurement of the thickness of nickel plating on uranium is described which depends upon the absorption in the nickel of the β radiation emitted by U-238. A halogen-quenched Geiger-Mueller tube is used as the detector. The range of thickness investigated was from 0 to 10 mils with achieved accuracies of better than $\pm 1/4$ mil over this range. (auth) (UK)

14868 MEASUREMENT OF ZINC COATING WEIGHT WITH β-RAY AT GALVANIZED STEEL SHEET. Tajima, Koichi (Nisshin Steel Co., Ltd., Tokyo). Nisshin Seiko Giho, No. 16, 52-8 (May 1967). (In Japanese).

A beta thickness gage for continuous measuring of the zinc coating weight of galvanized steel sheets for quality control is described. (TSS)

Miscellaneous Instruments and Components

Refer also to abstracts 14607, 14612, 14731, 14750, 14751, 15012, 15193, 15281, 15632, 15915, 16159, 16303, 16304, and 16362.

14869 (BNL-50057, pp 54-9) INSTRUMENTATION. (Brookhaven National Lab., Upton, N. Y.).

The development of radiation detectors and related instruments of general interest for atomic research at BNL is outlined. Work on germanium radiation detectors, on-line computer systems, direct-readout spark chambers, and other instruments and circuits are summarized. (W.H.K.)

14870 (BNL-50057, pp 101-8) APPLIED MATHEMATICS. (Brookhaven National Lab., Upton, N. Y.).

Developments in applied mathematics research and computer programming research from July, 1966 to July, 1967 are briefly outlined. (W.H.K.)

14871 (CEA-R-3276) ETUDES ET REALIZATION D'UNE "COUPE CE FARADAY" POUR LES MESURES DE FAIBLES COURANTS ELECTRONIQUES. (Design and Construction of a Faraday Cup for Measuring Small Electron Currents). Veyssiere, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 28p. (In French). Dep.

The design of a device for measuring and integrating very small currents generated by the impact of a charged particle beam upon a Faraday cup is described. The main component is a graphite bloc capable of stopping practically all the incident charges. The associated electronic apparatus required to measure better than 10^{-13} ampere with a precision of 1 per cent is also described. (auth)

14872 (CEA-R-3340) ICTOMETRE NUMERIQUE A GRANDE CONSTANTE DE TEMPS POUR TRES FAIBLE TAUX DE COMPTAGE: RESULTATS D'EXPLOITATION. (Numerical Ictometer With Large Time Constant for Very Low Count Rates: Operational Results). Kaiser, Josef (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 16p. (In French). Dep.

The use of an analog ictometer poses technical problems for measuring low count rates. These latter call for time constants of up to 1000 sec. The numerical technique is better adapted and makes it possible to increase the time constant to 1000 sec or over. The equipment described consists of 6 numerical ictometers fitted in a 3 U 3 drawer. By means of a clock it is possible to vary the counting time from 1 second to 1000 seconds, using values at 5, 10, 50, 100 and 500 seconds. The corresponding values of the frequency are 500 c/sec, 100, 50, 10, 5, 1 and 0.5 c/sec with a resolving power of 0.2 percent. The result appears on an indicator panel (galvanometer) and is available in the form of an analogue voltage suitable for a 50 mV MECI recorder. (auth)

14873 (JUL-500-RX) EIN NEUES NEUTRONEN-DOPPEL-DIFFRAKTOMETER. (A New Neutron Double Diffractometer). Jumpertz, E. A.; Scharenberg, W.; Stechemesser, H.; Althaus, U. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Aug. 1967. 49p. (In German). Dep.

A detailed description is given of a new neutron double diffractometer, with individual consideration of the design and construction of the diffractometer itself, the collimators, the electronics, dose output measurements, and shielding. The first measurements carried out were the measurement of the neutron flux density and determination of the resolution of the installation. Modifications already made and those planned on the basis of the first measurements are described. (J.S.R.)

14874 (KAPL-3382) CASCADE AND THREE-STAGE MASS SPECTROMETER VACUUM SYSTEMS. McHugh, J. A.; Sheffield, J. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 20, 1967. Contract W-31-109-eng-52. 20p. Dep. CFSTI.

A completely new vacuum system of the cascade mass spectrometer and the modifications made to the vacuum system of the three-stage spectrometer are described. Both systems are now bakeable and of all-metal construction, and both systems employ well trapped mercury vapor pumps. (auth)

14875 (NP-17229) RAPPORT D'ACTIVITES, 1966–1967. (Report on Activities, 1966–1967). (Commissariat a l'Energie Atomique, Tunis (Tunisia)). 94p. (In French). Dep.

The general structure of the Tunisian CEA is outlined, and the formation of a documentation center is reported. Studies made with a 14-MeV, neutron generator, desalination of water, prospecting for uranium ores, use of radioisotopes, radiation protection and control, nuclear electronics, and solar energy are briefly summarized. The cooperation with national and international organizations is described. (J.S.R.)

14876 (UCRL-17306) ESR SPECTROMETER FOR GASEOUS MEDIA. PART I. PRELIMINARY DESIGN. Lamers, Kenneth W. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 65p. Dep. CFSTI.

The spectrometer described here is designed to measure the rate of change of very small concentrations of hydrogen atoms. It has not yet been tested with regard to the design objective, so the design philosophy, operating procedures, and electronic performance only are described. The spectrometer is designed to recover absorption spectra directly, as opposed to the customary derivative. The cavity resonator (1420 MHz) is connected in a transmission scheme that uses barretter detection. The field modulation frequency is 280 Hz; the magnetic field strength is approximately 2 gauss. (auth)

14877 (AD-660763) TUNNEL-DIODE SCALERS. Sidorov, A. S. Translated from Poluprov. Prib. Ikh Primen., Sb. Statei, No. 14, 131-42(1965). 13p. (FTD-HT-67-38).

The principles of operation and characteristics of two pulse counters using tunnel diodes are described. The first is a three-stage binary counter whose input circuit and interstage coupling circuits consist of monostable multivibrators. For each positive pulse, the multivibrators give out two consecutive pulses of opposite polarity. All the tunnel diodes utilized in the circuit are Soviet-made GaAs diodes carrying the designation 3I30IV. Tests made of an eight-stage counter of the same design showed flawless performance, even at bias voltage variations of 7.0–9.2 V. The maximum counting frequency never fell below 10 Mc. The eighth stage was activated 30 nsec after the appearance of a signal at the counter input. The second pulse counter uses series-connected tunnel diodes which are switched in succession. The output appears after application of a number of pulses at the input equal to the number of series-connected tunnel diodes. The capacitors at the input are necessary for the formation of slow wavefronts which allow sufficient time for the internal capacitances of the diodes to charge up. A threshold element consisting of an emitter follower with TD_4 as the load activates the output pulse. The counter performed satisfactorily at bias voltage variations of 6.5–10 V. The maximum frequency of the counter was 10–12 Mc. (auth)

14878 (ANL-Trans-554) RESPONSE TIME OF MINIATURE SHIELDED THERMOCOUPLES. Schroeder, R. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Motortech. Z., 25: 297-9(1964). 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The thermocouples were shielded with metal and possessed the diameters 0.5, 1.0, and 2.0 mm. Response times were measured in hot carbon dioxide, hot nitrogen, and hot water as functions of the flow velocity. Also, data are presented to describe the response time dependence on the diameter of the thermocouple leads. (W.H.K.)

14879 RECENT DEVELOPMENTS IN MULTICHANNEL PULSE HEIGHT ANALYSERS. Bernstein, D. M. (Intertechnique, Plaisir, France). Nucl. Eng., 13: 112-16(Feb. 1968).

A description is given of the progressive development of analyzer design until instruments are available with 4,000 channels, and analog-to-digital converter rates of 20 to 100 MHz. Aspects discussed include the memory and computing section, analog-to-digital converter, linearity and stability, time programming, and data read-out. (UK)

14880 PRECISE DETERMINATION OF DROP WEIGHTS. van der Eijk, W.; Moret, H. (Central Bureau for Nuclear Measurements, Geel, Belgium). pp 529-35 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

A brief review is given of the two most precise methods currently used for the quantitative deposition of liquid drops, which are usually accurate to only ±0.5%. In the first method, the extrapolation method, the weight of the drop is measured as function of the time t, and the original weight is obtained by extrapolation to t = 0. The errors inherent in this method are evaporation during the drop formation, the different evaporation velocities at different times after the deposition of the drop (extrapolation), buoyancy effects and processes taking place in the time that the drop takes to leave the pipette and reach the source mount. The magnitude of these individual effects is discussed. The error due to the extrapolation can be reduced by placing the thin plastic source mount on a metal disc, and that due to the evaporation during the drop formation by a proper choice of t = 0. The second procedure often used, the pycnometer method, consists of the determination of the weight of a vessel before and after dispensing a drop of a solution. Possible sources of errors are evaporation from the vessel, evaporation of liquid on the outside of the item of the pycnometer, difference in buoyancy before and after dispensing the drop and splashing of the drop when it reaches the source mount. By a proper choice of the pycnometer and the experimental conditions these effects can be reduced considerably. Some typical figures for these effects are given. A combination of these two methods is described, in which for the same sample the amount of solution taken out of the pycnometer and the amount deposited on the source mount is determined. This procedure makes it possible to eliminate the main errors and to compare both methods. The experiments are carried out with a recording electro-balance developed at the CBNM, with a maximum load of 3 g and a precision of 0.5 μg. A non-mechanical method for expelling a drop by expanding air is described. An accuracy of better than 5 μg can be reached for the drop weight. This high accuracy allows also investigation of possible small sorption and demixing effects which have always been neglected. (auth)

14881 CALCULATOR FOR STANDARD DEVIATION AND OPTIMUM CONDITIONS IN RADIOACTIVE MEASUREMENTS. Kamburov, Kh. K. (Inst. of Physics, Sofia). pp 651-5 of Standardization of Radionuclides. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on the Standardization of Radionuclides, Vienna. See STI/PUB-139; CONF-661012.

A calculating device is described, suited for fast orientation in the conditions of radioactive measurements. Its usage minimizes the time needed for calculating the statistical accuracy and minimum detectable activity. The typical problems which could be solved by using it are as follows: calculation of the statistical accuracy (percentage natural standard deviation) for any radioactive measurement, determination of the minimum detectable activity (in count rate) for a chosen probability limit of the net count rate of the order of 90 to 99%, determination of the optimum statistical conditions of the measurement, and choice of the most suitable detector. The disadvantages of the existing automatic detectors used for measurement of radioactive samples are discussed and the ways to avoid them are shown. A counting device designed to measure radioactive samples with programmed statistical accuracy is described. (auth)

14882 TUNNEL DIODES AND THEIR USES IN NUCLEAR ELECTRONICS. PART. II. Patrutescu, M. Stud. Cerc. Fiz., 19: 173-214(1967). (In Rumanian).

The uses of tunnel diodes in various electronic circuits are considered. The operating variables of these diodes and those of similar electronic transistorized circuits are compared, and the operation of several tunnel diode circuits is analyzed. (Rom. Sci. Abstr.).

14883 A HIGH-STABILITY DISCRIMINATOR USING A COMMON DIODE AS DISCRIMINATING ELEMENT. APPLICATION TO A MULTIPLE CHANNEL PULSE HEIGHT ANALYZER. Klein, S. S.; Hulstman, L.; Blok, J. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods, 60: 88-92(Feb. 1968).

A discriminator is described in which the decisions depend on the change in differential resistance of a forward biased diode when the bias current is compensated by a current pulse. The sensitivity, in the version described, is about 0.5 V; the dynamic range (depending on the properties of the diode) at least 1 : 50. The stability is about 0.3 mV/°C. The dead time is 1.4 μs; it may be shortened for suitable input pulses. Several discriminators of this type have been combined into a multiple channel pulse height analyzer with an anticoincidence input for gating purposes. This apparatus was experimentally tested in an α-γ angular correlation experiment. Multiple channel systems are compared with multiple detector systems. Where possible the former should be used. (auth)

14884 ON RESOLUTION MEASUREMENTS WITH Ge(Li) DETECTORS AND RLC FILTER USING POLE-ZERO CANCELLATION TECHNIQUE. Benoit, R.; Mandl, V. (EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 60: 121-2(Feb. 1968).

A comparison between the conventional RC-CR filter network and the RLC with pole-zero cancellation is presented. The results obtained show an insufficient filtering of low frequencies by the RLC filter. (auth)

14885 SIMPLE PHOTOMULTIPLIER PERFORMANCE MONITOR. Lavoie, L.; Norton, R. (Univ. of Chicago). Nucl. Instrum. Methods, 60: 123-4(Feb. 1968).

A PMT noise rate monitor is described which gives a continuous indication of the proper operation of phototube, base, power supply, and logic first discriminator. (auth)

14886 LINEARITY MEASUREMENT TECHNIQUE FOR ANALOGUE-TO-DIGITAL CONVERTERS. Lycklama, H.; Kennett, T. J. (McMaster Univ., Hamilton, Can.). Nucl. Instrum. Methods, 59: 56-60(Feb. 1968).

A rapid, accurate and efficient technique for determining the differential linearity of analog-to-digital converters is presented. The method is applicable to any ADC having a zero offset and is completely independent of the linearity of the test equipment. By sampling the entire range of the converter concurrently, independence from instabilities is achieved. (auth)

14887 GAMMA-GAMMA LINEAR POLARIZATION MEASUREMENTS. Davies, K. E.; Hamilton, W. D. (Univ. of Sussex, Eng.). Nucl. Instrum. Methods, 59: 1-21(Feb. 1968).

The factors entering into the design of linear polarization correlation experiments and the analysis of the experimental data are discussed, particular attention being paid to the effects of finite angular resolution. A two-NaI-crystal summing polarimeter based on Compton scattering was used for the linear polarization measurements and was calibrated empirically over an energy range extending from 300 to 1200 keV. A discussion is given of the significance of the results obtained. (auth)

14888 CALIBRATION OF TIME-TO-AMPLITUDE CONVERTERS. Baker, C. A.; Batty, C. J.; Williams, L. E. (Rutherford High Energy Lab., Berks, Eng.). Nucl. Instrum. Methods, 59: 125-30(Feb. 1968).

A method of calibrating time-to-amplitude converters is described using a random time spectrum and a calibration circuit which produces pulses separated by a known period. A least-squares analysis of these continuous and discrete spectra yields time as a polynomial in channel number with an accuracy substantially better than 1%. (auth)

14889 AUTOEQUALIZING METHOD TO INCREASE THE SPEED OF ANALOG TO DIGITAL CONVERSION. Abbattista, N.; Coli, M.; Plantamura, V. L. (Univ., Bari, Italy. CNEN, Frascati, Italy). Nucl. Instrum. Methods, 59: 163-6(Feb. 1968).

Two methods are proposed and analyzed for analog to digital conversion based on the digital prevision of the incoming pulse amplitude in order to obtain a good speed performance (with a 1024 channel converter the expected conversion time is ≈4.2 μsec). Moreover it is possible to obtain a very good differential linearity by the instrinsic capability of two methods to perform a statistical equalization of the channel width. (auth)

14890 FATIGUE EFFECTS ON THE CHANNELTRON ELECTRON MULTIPLIERS. Cantarano, Sergio; Edigi, Alberto; Marconero, Renzo; Pizzella, Guido; Sperli, Filippo (Univ., Rome). Ric. Sci., 37: 387-92(May 1967). (In Italian).

Preliminary experimental results recording the fatigue effects on the Channeltron electron multipliers are given. It was found that: the gain G decreases when the Channeltron is bombarded with a high intensity electron beam, but it always recovers in due course; the particle detection efficiency ϵ does not vary; for a given incident flux of electrons the gain G decreases until it approaches a limiting value G_∞. These results show that the Channeltron can be satisfactorily employed for measurements aboard artificial satellites without severe limitations due to fatigue. (auth)

14891 PRELIMINARY RESULTS OF A STUDY OF AN ELECTROSTATIC DEFLECTOR FOR THE MEASUREMENT OF THE SOLAR WIND ABOARD THE EUROPEAN SATELLITE HEOS A. Egidi, Alberto; Pizzella, Guido; Terenzi, Mario (Univ., Rome). Ric. Sci., 37: 393-8(May 1967). (In Italian).

The motion of charged particles in a hemispherical electrostatic deflector was computed. The results of the calculations were compared with the results of measurements made using an electron beam and found to agree well. In particular, our empirical model for the fringing field effects appears to be adequate. An electrostatic analyzer of the kind considered here will fly aboard the European satellite HEOS A. (auth)

14892 CONSTRUCTION AND USE OF THE GRONINGEN ISOTOPE SEPARATOR. Drentje, S. A. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Instrum. Methods, 59: 64-72 (Feb. 1968).

The Groningen electromagnetic isotope separator which is of the so-called Scandinavian type with a Nielsen ion source, operates with about 50 kV acceleration potential and a homogeneous 90° magnetic sector field with a mean radius of 80 cm. Small ion sources are developed, which are interchangeable through a vacuum lock. The circular source aperture yields a line focus on the collector plate, the beam half width at the collector being about 1 mm. The beams are scanned with a thin vibrating needle; their position is stabilized. Among the applications of the isotope separator we mention studies on secondary electron emission and sputtering of metals by noble gas ions, the effects of gas desorption, the preparation of radioactive samples for nuclear spectroscopy, internal field measurements near implanted ions in magnetic materials. (auth)

14893 CONTINUOUS SAMPLING METHOD FOR THE ANALYSIS OF RADIATION CHEMISTRY PROCESSES IN REACTORS. Wilson, H. W.; Scott, W. M. (Scottish Research Reactor Center, Glasgow). Nucl. Instrum. Methods, 59: 176-8(Feb. 1968).

A mass spectrometry method is described, which permits the examination of reactor radiation chemistry products at short times (of the order of seconds) after formation. (auth)

14894 ALIGNMENT AND CALIBRATION OF FAST MULTICOINCIDENCE SYSTEMS. Nadav, E.; Palmai, M.; Salzmann, D. (Hebrew Univ., Jerusalem). Nucl. Instrum. Methods, 59: 173-5 (Feb. 1968).

A variable delay circuit, which facilitates automatic accumulation of coincidence delay curves on a multichannel analyzer is described. The correlation between the widths of the delay curve, the coincidence and the detector's time spread, is analyzed mathematically. (auth)

14895 TECHNIQUE FOR INTERNALLY STRAIN GAUGING SMALL DIAMETER NOZZLES. Grindrod, A.; Fearnley, R. P. (Berkeley Nuclear Labs., Eng.). Strain, 4: 32-4(Jan. 1968).

Experimental investigations into the behavior of nozzle assemblies in pressure vessels have required development of a reliable method of accurately positioning electric resistance strain gauges on the inner surfaces of blank-ended nozzles between 1½ ins. and 4½ ins. diameter and up to approximately 12 in. deep. Accurate location of the gauges, both radially and longitudinally, is demanded by the fact that high strain gradients are likely to occur at structural discontinuities such as intersections, fillet welds, etc. Since the gauges may be subjected to both post yield strains of the order of 5% and hydrostatic pressures of 1000 lbf./sq in., it is of the utmost importance to ensure that the adhesive bond is reliable and that repeatability can be obtained. (auth) (UK)

14896 MEASUREMENT OF INTERNAL STRAIN IN CONCRETE. McKillen, R. R.; Brading, K. F.; Williams, A. (Atomic Power Constructions Ltd., Hounslow, Eng.). Strain, 4: 24-30 (Jan. 1968).

Methods of strain measurement in concrete were investigated experimentally. Work is reported on embedded resistance strain gauges mounted on concrete and other forms of gauge carrier, techniques for strain gauging embedded steelwork, results of gauge factor tests on briquetted and unbriquetted vibrating wire gauges, and gauge responses to temperature variations. Proposals are outlined for future work particularly on stress meters as distinct from strain gauges. (auth)

14897 HIGH VOLTAGE DIVIDER AND LEAKAGE MONITOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). CAPE-1669).

50 drawings.

An instrument is described which is used to detect current and remove high voltage from lithium-drifted radiation detectors. The high voltage divider circuit is usable with either polarity to 3 kV while the current measuring circuit provides a metered indication of load current from 0.1 nA to 1 mA. The leakage protection circuit may be set to any current within this range and adjusted to operate at three times the full scale meter reading, even if the manual setting is misadjusted. With simple adjustments the instrument can be used with any high voltage equipment. The current measuring circuit is a solid-state equivalent of the vacuum tube voltmeter, using field effect transistors to obtain high impedance. (For details see TID-4100 Suppl. 43.) (F.S.)

14898 DUAL PULSE GENERATOR AND DISCRIMINATOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1660).

70 drawings.

A pulse generator is described which has dual input and output circuits driving a common set of ten output connectors in parallel. The power supplies and ac circuits are separate with the exception of the ac input connector. One "trigger made" switch controls both channels. There are two discriminator channels and two inputs to each channel for triggering either a positive or negative signal. The discriminator range is 4 to 104 V. Power requirements are 105 to 125 V ac at ½ A. (For details see TID-4100 Suppl. 43.) (F.S.)

14899 ELECTRONIC SECTOR FOR THE BEAM MONITORING SYSTEM (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE-1678).

143 drawings.

The beam position monitoring electronics located at the 30 sectors of the Stanford Linear Accelerator are described. Beam position monitoring is used to accurately determine the transverse position of the beam within the accelerating structure. Multiple beams of different charge are used and the monitor observes the position of each beam independently. The electronics described consists of integrators, gates, amplifiers, timing logic circuits, trigger generators, jumpers, baseband telemetry transmitter and receiver, transformers, and switches. (For details see TID-4100 Suppl. 44.) (F.S.)

14900 CONTROLLED-POTENTIAL AND CONTROLLED-CURRENT CYCLIC VOLTAMETER (Engineering Materials). (Oak Ridge National Lan., Tenn.). (CAPE-1653).

2 drawings.

An instrument is described which is used for linear potential sweep voltammetry, chronopotentiometry, and chronoamperometry. Operation amplifiers are used for control and measuring devices. The basic potentiostat is switched so that either the electrode potential or the cell current is controlled. Recording of the current-potential, potential-time, or current-time curves may be on a pen and ink x-y recorder or on an oscilloscope. In the controlled-

potential mode the electrode potential may be stepped from one value to another or swept linearly between any limits up to ±3 V. Potentials at which the sweep reverses or the electrolysis terminates is preselected; the sweep rate is independent of these potentials. In the controlled-current mode, the electrode potential is controlled prior to the application of the current step. Polarity of the current is reversed at two preselected potentials or the electrolysis may be terminated after reaching either of these potentials. A preset cycle counter permits any single cycle up to the hundredth to be recorded. Circuit design and construction may be modified by the addition of current integration or potential-time or current-time differentiation. (F.S.)

14901 IMPROVEMENTS IN OR RELATING TO ELEVATOR MECHANISM FOR APPARATUS DETECTING AND MEASURING RADIOACTIVITY. (to Packard Instrument Co., Inc.). British Patent 1,101,902. Feb. 7, 1968. Priority date Apr. 13, 1965, United States.

An elevator mechanism for moving sample-carrying containers into and out of a detection well in scintillation apparatus for detecting and measuring radioactivity emanating from the samples is described. The sample is centered in the light-tight detection well and is moved on a platform mounted on the elevator shaft in the well. (W.H.K.)

Radiation Effects on Instruments and Instrument Components

14902 RADIATION EFFECTS IN METAL-INSULATOR-SEMICONDUCTOR CAPACITORS AS DETERMINED FROM CONDUCTANCE MEASUREMENTS. Perkins, C. W. (Hughes Aircraft Co., Fullerton, Calif.). Appl. Phys. Lett., 12: 153-5(Feb. 15, 1968).

Conductance-versus-voltage measurements were employed to determine the distribution of fast interface states in MOS and MNS capacitors and the changes in these distributions due to gamma irradiation with applied bias. MNS samples showed no changes due to irradiation, while MOS samples showed an increase in the conductance peak due to an increase in the density of the fast states. (auth)

14903 RADIATION EFFECTS IN SEMICONDUCTOR DEVICES AND THEIR APPLICATIONS. Oku, Taiji; Horie, Kazuo (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 41: 1417-24(Nov. 1967). (In Japanese).

Selected Si diodes have been irradiated mainly by gamma rays from cobalt-60. Changes in lifetime and other characteristics are presented in terms of integrated gamma ray flux. The annealing behavior in the lifetime is also reported. From such data the introduction rate of the A-center in the phosphorus-doped n-type base region, pulled from the melt and aluminum-alloyed, is found to be 2.2×10^{-3} defects/cm^3 per photons/cm^2. In the float-zoned and phosphorus-doped n-type base with a gallium diffused junction, the introduction rate of the E-center is much less than that in float-zoned n-type crystals with no junction, and the A-center seems to be the dominant recombination center. The radiation effects on Si diodes can be made use of for exposure meters. To study the lifetime control in the thyristor, changes in turn-off-time, turn-on-time and other characteristics have been investigated as a function of the integrated gamma ray flux. (auth) (NSA of Japan)

14904 NONLINEAR ELECTRICAL FIELD IN A RADIATION-IONIZED DIELECTRIC. Rozenkrants, A. S. Elektrichestvo, No. 6, 52-8(1966). (In Russian).

The reversible changes in electric and nonelectric parameters in instrumentation operating under the effect of ionizing radiation are described. The changes are observed during the period of radiation and depend on the intensity of the radiation dose. Special attention is directed to the effect of such radiation on the electric field and on the parameters which depend directly on this field (conductance, capacitance, electrical strength, loss angle, etc.). The development and substantiation of theoretical principles for the analysis of these responses, using probabilistic and mathematical simulation techniques are discussed. It is shown that the analysis of an electrical field in an irradiated object (specifically, a gaseous dielectric) can be reduced to the solution of a Poisson equation boundary problem, with the volume charge distribution not known a priori, since this distribution depends on the configuration of the field and is determined from a system of partial nonlinear deferential equations. It is shown that analysis of the field distortions caused by the volume charges generated by ionizing radiation is possible and can be significantly simplified via the introduction of a similitude criterion in the description of the fields. Provided the primary similitude criterion (M) values are small, recombination (saturation mode) can be disregarded and, for simple electrode configurations, an analytic expression can be derived for the intensity at every point in the field. If the values of M are large, failure to make allowance for recombination leads to significant errors, and when $M \geq M_{critical}$, a solution which disregards recombination is altogether impossible. The field in an irradiated object, with recombination considered, in the steady-state mode and with simple electrode configurations, can be analyzed on a continuous electronic model. More complex cases require the use of digital computers. The larger M, the greater the heterogeneity of the field due to ionizing radiation, so that test instrumentation errors and inaccuracies may occur even at relatively low levels of radiation. (ATD)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 14429, 14462, 14563, 14757, 14984, 15002, 15023, 15032, 15076, 15084–15087, 15101, 15103, 15108, 15112, 15120, and 15124.

14905 (BNL–50057, pp 111-22) BIOLOGY. (Brookhaven National Lab., Upton, N. Y.).

Research in progress in the Biology Department is related to the development of basic information that will lead to improved understanding of the manner in which ionizing radiations affect living things. Emphasis is placed, where possible, on the molecular approach. (E.R.B.)

14906 (BNL–50057, pp 123-37) MEDICAL RESEARCH. (Brookhaven National Lab., Upton, N. Y.).

Medical research is reported on: effects of radiation; metabolism of trace elements, radioisotopes, and amino acids; expansion of application for the extracorporeal irradiation technique; new and improved methods for medical radiography and radioisotope scanning; structure and function of nucleic acids and proteins; and immunological phenomena. (E.R.B.)

14907 (COO–875-80) CONFORMATIONAL CHANGES IN SEVERAL ENZYMES DURING PHOTODYNAMIC INACTIVATION. Hopkins, Thomas R. (Utah Univ., Salt Lake City. Dept. of Molecular and Genetic Biology). Aug. 1967. Contract AT(11-1)-875. 163p. Dep. CFSTI.

Conformational changes in ribonuclease, trypsin, chymotrypsin, and lysozyme during the course of photodynamic inactivation were studied. Methylene blue, eosin Y, and in some experiments, flavin mononucleotide were used as sensitizing dyes. Conformation-sensitive parameters studied include fluorescence, the behavior on molecular sieve and ion-exchange chromatography, electrophoresis mobility on cellulose acetate, immunological reactivity, sensitivity to thermodenaturation, fluorescence polarization, viscosity, solubility, fluorescence transitions in urea and protein digestibility. A secondary objective of this thesis was to determine whether altered forms of enzyme molecules still possessing catalytic activity were produced as a result of photodynamic treatment. The altered characteristics examined were urea sensitivity, salt sensitivity, thermosensitivity, digestibility, and low enzyme turnover. For comparative purposes, the enzymes were also photoinactivated in 8M urea. In general, all four enzymes showed some structural alteration. With ribonuclease and lysozyme, the rate of alterations correlated directly with the rate of loss of enzyme activity. This is evidence that at least some of the photoinactivation of these enzymes occur by changes in protein conformation. Chymotrypsin and trypsin showed slight conformational changes but the rate of these changes did not correlate directly with the loss of enzyme activity. When eosin Y was used as the sensitizer for all four enzymes, one or two tryptophan residues were rapidly destroyed at a rate similar to the rate of enzyme photoinactivation, indicating that a tryptophan residue may be involved in the maintenance of enzyme activity. Charge interactions of the respective proteins were disrupted; ion-exchange chromatography and electrophoresis patterns of the photoinactivated enzymes were characteristic of less basic proteins than the native enzymes. The rates of photooxidation of trypsin, chymotrypsin, and ribonuclease in 8M urea were, in general, several times faster than the rates in buffer alone. The native enzyme structure protects some amino acid residues from destruction by photodynamic action. During the photodynamic inactivation of all four enzymes, active but altered enzyme molecules were produced. Urea-sensitive enzyme fractions were found with trypsin and ribonuclease using flavin mononucleotide but not methylene blue or eosin Y as the sensitizer. Thermosensitive enzyme fractions were produced during the photodynamic inactivation of ribonuclease and lysozyme with all three sensitizers. Because of their autolytic properties, trypsin and chymotrypsin could not be tested for thermosensitivity. A low turnover enzyme was detected during the photodynamic inactivation of chymotrypsin as sensitized by all three dyes. Partially photoinactivated enzyme with unusual sensitivity to 1.2N sodium chloride, was not found with any of the four enzymes. In conclusion, it was demonstrated that photodynamic treatment can produce altered enzymes that still retain intact active sites. Furthermore, some enzymes apparently lose catalytic ability as a result of the destruction of secondary and tertiary structure. (H.L.W.)

14908 (COO–1156-25) TISSUE DISTRIBUTION AND EXCRETION OF ^{134}Cs IN THE MULE DEER. Hakonson, Thomas E. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Aug. 1967. Contract AT(11-1)-1156. 121p. Dep. CFSTI.

Thesis.

Pen studies were undertaken to determine the uptake and elimination rate of ^{134}Cs from mule deer (Odocoileus hemionus hemionus). In addition, data were collected on tissue distribution patterns of ^{134}Cs in adult and fetal deer. The mean biological half-times associated with the two component retention curves were about 0.5 days and 14 days. The value of the slow elimination component extrapolated to the time of dosing (percent uptake) averaged 77 percent of the initial dose. It was found that cesium elimination rates of yearling and adult deer were not significantly different. However, fawns (<5 months old) eliminated cesium more rapidly than adults. Sex per se had no significant effect on cesium elimination rates. Reduced feed intake and larger body weights significantly increased the cesium elimination half-times. Cesium uptake and elimination rates in deer fed dietary levels of 0.8 percent and 6.0 percent potassium and 9.6 percent and 24.1 percent crude fiber were not significantly different. Deer confined to 3 × 6 foot and 12 × 20 foot pens did not have significantly different cesium elimination rates. Concentrations of ^{134}Cs in fawns receiving the radiocesium via the dam's milk, reached equilibrium body concentrations within five days. Concentrations of ^{134}Cs were readily measurable in nearly all tissues of deer. The largest fraction of an ingested dose accumulated in the muscle. At dose-sacrifice intervals of 10 to 19 days, about 80 percent of the total body cesium was found in skeletal muscle. Cesium transfer to unborn fetuses was readily detectable and concentrations in some cases were higher than in the dam. (auth)

14909 (COO–1156-26) FACTORS INFLUENCING THE ACCUMULATION OF ^{90}Sr, STABLE STRONTIUM, AND CALCIUM IN MULE DEER. Farris, Gerald C. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Aug. 1967. Contract AT(11-1)-1156. 189p. Dep. CFSTI.

Thesis.

Concentrations of ^{90}Sr, stable strontium, and calcium were measured in mule deer bone and in eight forage species that were samples over a five year period from the Cache la Poudre drainage in north central Colorado. Vegetation was collected from sampling points within each of the major plant communities utilized by deer. A definite temporal trend in ^{90}Sr concentrations in plants and bones of fawn and yearling deer was observed from 1961 to 1965. Plants and deer reached peak ^{90}Sr concentrations in 1963 with decreases in activity in 1964 and 1965. Summer forage plants were generally higher in ^{90}Sr, stable strontium, and calcium levels than in those species available to the deer in the winter. However, more variation was observed between species and locations of summer range plants than in winter range plants. Comparisons were made on ^{90}Sr, stable strontium and calcium levels observed in forage and deer rumen contents. Yearly mean ratios were similar indicating that nuclide content of plants sampled was representative of the actual consumption by deer. Stable strontium levels in deer bone ranged from 0.184 to 0.632 mg Sr/g ash. Lower stable strontium concentrations were observed in fawns than in mature deer. No significant differences in ^{90}Sr, stable strontium, and calcium concentrations were observed between the sexes of deer. Observed ratios (Sr/Ca in bone ÷ Sr/Ca in diet) of 0.316, 0.183 and 0.189 were calculated for fawn, yearling and adult deer, respectively. Annual turnover rates of strontium in bone were estimated as 32 percent for yearling and 7 percent for adult deer. A mathematical equation was used to calculate ^{90}Sr concentrations in the bones of deer as a function of their age. Predicted ^{90}Sr concentrations agreed well with the observed data. (auth)

14910 (COO–1244-12) AN ELECTRON MICROSCOPIC AND AUTORADIOGRAPHIC STUDY OF INTESTINAL RADIATION DEATH IN THE MOUSE. Technical Progress Report. Hampton, James C. (Northwestern Univ., Chicago, Ill. Dept. of Anatomy). Oct. 27, 1967. Contract AT(11-1)-1244. 5p. DTIE.

X RADIATION—effects on enzyme content of epithelium in intestine of mice; effects on uptake of Thorotrast by liver cells

PERMEABILITY—radiation effects on, of capillaries in epithelium of intestine in mice, combined effects of taurocholic acid on x

RADIATION—effects on mucosa of duodenum in developing chickens

NUCLEIC ACID, RIBO—content of cells in pancreas of mice, effects of actinomycin D on (E.R.B.)

14911 (COO-1691-1) MECHANISM OF URANIUM POISONING AT THE LEVEL OF THE MAMMALIAN RENAL TUBULE CELL. Annual Progress Report, 1967. (Cincinnati Univ., Ohio. Dept. of Environmental Health). Nov. 21, 1967. Contract AT(11-1)-1691. 2p. Dep. CFSTI.

URANYL ACETATES—effects on permeability of tubular epithelium in kidneys of rabbits; effects on paraminohippurate transport in kidneys of rabbits

HIPPURIC ACID, P-AMINO—salts, transport in kidneys of rabbits, effects of uranyl acetates on (E.R.B.)

14912 (NYO-3834-1) MODIFICATION OF RADIATION EFFECTS IN CULTURED MAMMALIAN CELLS. Progress Report, April 1, 1967–March 30, 1968. Todd, Paul W. (Pennsylvania State Univ., University Park. Dept. of Biophysics). Jan. 1968. Contract AT(30-1)-3834. 7p. Dep. CFSTI.

There is apparently no hypoxia induced by high-intensity radiation delivered in total doses in the range of 1000 rads. Hydroxyurea is a limited cytocidal agent, in that its action may depend upon cell type within as well as among species. Azaguanine appears to be a poor radiosensitizer of aerated human cells and appears to be without cytotoxic effects upon hamster cells. An attempt is being made to clarify the effect of methotrexate on recovery. The apparent independence of recovery from oxidative metabolism has been corroborated. Ultraviolet-light-induced sublethal lesions are not repaired as rapidly as x-ray induced lesions, and the ultraviolet action spectrum does not directly implicate hydration and dimerization of pyrimidines as vital lesions. Data were accumulated on the induction, reversion, metabolism, structure, and cytogenetics of defective cell lines isolated from x-irradiated and ultraviolet-exposed cultures; their only consistent properties appear to be x-radiation sensitivity and slow growth. Lipocells are amoebae. (auth)

14913 (ORNL-TM-2042) METABOLISM OF HERBICIDES IN ECOSYSTEMS. A Review. Edwards, N. T.; Van Dyne, G. M. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 34p. Dep. CFSTI.

The need for a better understanding of the fate of some of the commonly used herbicides in ecosystems prompted a general review of the literature, with emphasis on (2,4-Dichlorophenoxy) acetic acid and (2,4,5-Trichlorophenoxy) acetic acid to summarize research that was conducted. Based on a selected but representative sample of the diverse literature on herbicides, research seems to have centered around effects of herbicides on animals, degradation of herbicides by soil microorganisms and the effects of herbicides on soil microorganism activity, behavior of herbicides within the plants, and persistence of herbicides and their effect on succeeding plant growth. This report presents abstracts of publications under the headings listed above, a brief discussion of the types of toxic action of some of the commonly used herbicides and chemical structural formulas for the most common herbicides. This review suggests that there is need for research on the movement and degradation of herbicides in ecosystems with special emphasis on transfer of herbicides from sprayed plants to animals which may feed on these plants under natural conditions, and further consideration on sublethal effects on nontarget organisms. (auth)

14914 (ORNL-TM-2069) MEASUREMENT OF METABOLISM IN COTTON RATS BY RETENTION OF ^{134}Cs. Baker, C. E.; Dunaway, P. B.; Auerbach, S. I. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 48p. Dep. CFSTI.

Biological half-lives (T_b) of ^{134}Cs were compared with resting metabolism measurements of cotton rats maintained at 5°, 15°, and 25°C in an endeavor to develop a technique for determining respiration rates of animals in the field. Average T_b values of the experimental groups were 6.3 days at 5°C, 6.9 days at 15°C, and 8.1 days at 25°C; oxygen consumption measurements (cc/hr/g) averaged 3.2, 2.3, and 1.5, respectively. Regression and correlation analysis performed on the data of the individual animals indicated a linear relation between T_b of ^{134}Cs and resting metabolism. Although ^{134}Cs retention correlated well with oxygen consumption, it apparently did not correlate with body weight. Further investigations of 24-hour oxygen consumption measurements made over a wider range of metabolic rates (i.e., both above and below thermoneutrality) and consideration of certain factors that promote elimination of cesium are necessary to validate the apparent relation between ^{134}Cs retention and general metabolism. (auth)

14915 (TID-24217) [RADIOISOTOPE UPTAKE IN BONE]. Technical Progress Report. [Ray, Robert D.] (Illinois Univ., Chicago). [1967]. Contract AT(11-1)-1601. 7p. Dep. CFSTI.

Topographic distribution of ^{45}Ca in bones of rats was determined by means of autoradiographic techniques. A difference was observed between living and devitalized bone in the subendosteal and subperiosteal areas. Local concentrations of the isotope over osteocyte lacunae and canaliculae occurred. Distribution of isotopes following single injections of ^{45}Ca and ^{14}C-labeled proline was studied in young rats in which one tibia had been removed, devitalized by freezing and thawing, and reimplanted. The dead tibia took up about 25% as much ^{45}Ca or ^{14}C as the control living bone. Studies on metabolism of minerals in human bone are being correlated with direct determinations of bone density using microradiography and autoradiography. Effects of high altitude on bone density and rates of formation and resorption are being studied. Effects of oxygen and carbon dioxide on skeletal metabolism in rats are being investigated. (H.L.W.)

14916 EFFECTS OF IONIZING RADIATION ON NUCLEIC ACIDS OF BACTERIOPHAGES AND BACTERIAL CELLS. Ginoza, William (Pennsylvania State Univ., University Park). Contract AT(30-1)-3116. Annu. Rev. Nucl. Sci., 17: 469-512 (1967). (NYO-3116-10).

Radiochemical lesions induced by ionizing radiations in nucleic acids of viruses and bacteria are described. The relation between these lesions and the loss of viability of these organisms is discussed. Analysis of radiation damage to nucleic acids by electron spin resonance is discussed with regard to yield of free radicals, nature and sites of free radicals in nucleic acid, intramolecular energy transfer, intermolecular energy transfer, and correlation between base composition and the yield of free radicals. A discussion of radiation polymer chemistry of nucleic acids is given. Other topics included are: target theory analysis of single-stranded nucleic acid viruses; target analysis of double-stranded DNA viruses; effects of ionizing radiation on nucleic acid components of the bacterial cell; radiation biology of bacteria; and implications of DNA as the primary target of the cell. (H.L.W.)

14917 ACCELERATION OF THE SYNTHESIS OF PROTEIN AND DNA IN CELLS OF EHRLICH'S ASCITES CARCINOMA BY γ-IRRADIATION IN RELATIVELY SMALL DOSES. Kuzin, A. M.; Khakimov, P. A. Radiobiologiya, 7: 328-31(1967). (In Russian).

The effect of γ-irradiation on the synthesis of proteins and DNA in cells of a transplantable strain of Ehrlich ascites carcinoma was studied by determining the incorporation of lysine-^{14}C and thymidine-$2^{14}C$, respectively, in cell material derived from tumors that had developed on the seventh day after parenteral inoculation of mice with the carcinoma. The synthesis of protein in the cells, as indicated by the incorporation of lysine-^{14}C, was increased on irradiation with doses up to 200 to 400 R in comparison with control cell material, while at doses above 1200 R, inhibition of the synthesis took place. The synthesis of DNA, as indicated by the rate of incorporation of thymidine-$2^{14}C$, was stimulated by irradiation at doses up to 200 R, while at doses $\geq$500 R, distinct inhibition of the synthesis occurred. Determination of the activity of proteins isolated following irradiation of the cells at 200 R confirmed that the rate of incorporation of lysine-^{14}C into proteins was higher than control material irradiated at this dose, i.e. the synthesis of proteins was stimulated. (JPRS)

14918 IODINE METABOLISM IN ENDEMIC GOITRE IN COUNTRIES OF THE MIDDLE EAST. PART I. AN APPRAISAL OF NEW RADIOISOTOPE TECHNIQUES IN THE STUDY OF IODINE METABOLISM. Abdel-Wahab, M. F.; Ibrahim, M. Salah (Middle Eastern Regional Radioisotope Centre for Arab Countries, Cairo. Ein-Shams Univ., Cairo). Isotopenpraxis, 3: 279-83(July 1967).

The use of different radioiodines and technetium for the evaluation of the thyroid functions is discussed. Preparation of labeled iodotyrosines and labeled thyroxine is mentioned for the convey of different radiochemical tests and for the use of reference standards necessary for the identification of separated amino acids. Paper chromatography and paper electrophoresis techniques were used for the identification and determination of iodinated amino acids or hormones, either in the free state or bound to the proteins. Technetium-99m was employed as a substitute for radioiodine in the study of uptake measurements of the thyroid gland and to evaluate the excretion of the isotope in urine. Sulfur-35-labeled thiourea was used for the first time in humans to study the metabolism of the substance in different thyroid disorders. (auth)

14919 STUDIES ON THE HOMOGENEITY OF FODDER MIXTURES IN THEIR INDUSTRIAL PRODUCTION. Beer, M.; Helbig, W. (Institut fuer Mechanisierung der Landwirtschaft, Max-Eyth-Allee, Ger.). Isotopenpraxis, 3: 284-8(July 1967). (In German).

A new labeling and measuring technique using ^{198}Au for the determination of content of individual constituents of fodder mixtures was developed. The technique was sufficiently exact and

rapid (more than 100 analyses per hour) and enabled the measurement of samples as large as wanted without special preparation. The studies were used for testing large-scale plants for the production, deposition, transport, and distribution of fodder mixtures. (auth)

14920 CARRIAGE OF IMMUNOLOGICAL MEMORY BY SMALL LYMPHOCYTES IN THE RAT. Gowans, James L.; Uhr, Jonathan W. (Oxford Univ.). J. Exp. Med., 124: 1017-30(Nov. 1, 1966).

Thoracic duct lymphocytes were collected from rats 1.5 to 15 months after a single immunizing dose of φX174 phage. The cells were injected intravenously into syngeneic hosts whose ability to respond actively to antigen was virtually abolished by prior irradiation. The hosts were then challenged with antigen to determine the character of the immune response that was conferred by the transferred cells. Finally, the response conferred by fresh thoracic duct cells was compared with that given by inocula of small lymphocytes from which the large, dividing lymphocytes were removed. Thoracic duct lymphocytes conferred on heavily (500 rad) x-irradiated rats the ability to form antibody in a secondary-type manner after a first injection of φX174. Negligible responses were obtained after cell transfer if the recipients were not challenged with antigen. Thoracic duct cells from some immunized donors were incubated in vitro for 24 hr before transfer to destroy selectively the large, dividing lymphocytes. The responsiveness conferred on x-irradiated recipients by such incubated inocula was then compared with that given by equal numbers of fresh thoracic duct cells. In all such comparisons the recipients of the incubated cells gave higher and more rapid antibody responses. It was concluded that the cells in thoracic duct lymph that carried immunological memory were small lymphocytes. (BBB)

14921 USE OF SCINTILLATION CAMERA FOR THE ESTIMATION OF BOTH MORPHOLOGICAL AND FUNCTIONAL STATES OF THE KIDNEYS. Dow, James A. (Tulane Univ. Primate Research Center, Covington, La.). J. Urol., 98: 159-62(Aug. 1967).

Studies conducted in monkeys led to development of a method that allowed the measurement of split renal function or individual effective renal plasma flow (RPF) by obtaining a scintillation camera image following the administration of ^{131}I-labeled Hippuran, without the need for ureteral catheterization. The principle is based on the fact that the light transmission of each kidney scan obtained by the scintillation camera is related to total uptake of radiohippuran, that in turn appears to be directly proportional to the RPF. An injection of 60 μCi of ^{131}I-Hippuran was made into the short saphenous vein of the monkeys. Qualitative estimation of split renal function by the scintillation camera coincided reasonably well with the effective RPF of each kidney measured by the radiohippuran clearances. Percentage differences between the 2 methods ranged from 0.5 to 9.0, with the mean value of 4.5%. Thus the mean efficiency of the scintillation camera for the measurement of split renal function fell within 95.5% of those of the radiohippuran clearances. In all animals, the scintillation camera picked up a larger quantity of the isotope from the right kidney compared to the left kidney in which the effective RPF was reduced due to the induced stenosis of its renal artery. A scintillation scan taken within 6 min after the injection represented the qualitative measurement of split renal function without much uptake of radiohippuran from the renal pelvis. (BBB)

14922 COMPOSITION OF ^{131}I RADIOACTIVITY IN PLASMA IN NORMAL AND ABNORMAL THYROID FUNCTION. Emrich, Dieter (Univ., Goettingen, Ger.); Uhl, Nikolaus Acta Endocrinol., 55: 573-86(Aug. 1967).

The ^{131}I radioactivity of plasma in 55 patients with normal and abnormal thyroid function was determined by paper chromatography carried out between 2 and 111 hr after diagnostic (300 μCi) and therapeutic doses of radioiodine. The relative concentration of ^{131}I-triiodothyronine (^{131}I-T_3) was mainly dependent on the time interval after the administration of ^{131}I. The relative concentration of ^{131}I-thyroxine (^{131}I-T_4) and ^{131}I-T_3 seemed to be independent of the dose of ^{131}I administered. In hyperthyroidism the relative percentage of ^{131}I-thyroxine was not changed as compared with that in euthyroid patients, whereas the relative percentage of ^{131}I-triiodothyronine showed an increase during the whole period of observation. Its decrease with the clinical improvement of hyperthyroidism was not significant. Evidence was obtained that thyrotrophic hormone (TSH) alters the ^{131}I-T_4/^{131}I-T_3 ratio in favor of ^{131}I-T_3 in human subjects. The incidence of detectable ^{131}I-labeled iodotyrosines appeared to depend on the dose of ^{131}I and the thyroid activity, but their share (the average not exceeding 6%) of the total radioactivity of plasma was independent of the amount of ^{131}I administered. (BBB)

14923 PLASMA CLEARANCE OF ^{85}Sr BY BONE: AN ATTEMPT TO STUDY THE RATE OF BLOOD FLOW THROUGH NORMAL AND IMMOBILIZED BONE IN DOGS. Semb, Helge (Univ. Hospital, Uppsala). Acta Soc. Med. Upsal., 71: 227-36 (1966).

Rate of removal of intravenously injected ^{85}Sr from blood by bone was measured in dogs. Radioactivity was followed in arterial plasma and bone marrow plasma after injection of 150 to 200 Ci doses of ^{85}Sr. Total blood flow through bone was measured by calculations based on Fick's principle as applied to the initial clearance by bone of intravenously administered ^{85}Sr. The difference of ^{85}Sr activity between arterial and bone marrow plasma was obtained from activity-time curves plotted for arterial plasma and for plasma obtained from cancellous bone. Uptake of ^{85}Sr was measured in the distal ends of radial bones, resected on conclusion of the experiments. The values for the blood flow through distal radial metaphyses ranged between 25 and 30 ml/min/100 g bone tissue. The ratios between the Sr activity (cpm/g fresh bone) in immobilized and normal bone were increased after about two weeks. For shorter periods there were no consistent differences in activity. When one fore-limb was immobilized for four days, the activity-time curve for plasma from the immobilized bone was identical with that for arterial plasma. (BBB)

14924 LYMPHOCYTE TRANSFORMATION TEST. Eijsvoogel, V. P.; Schellekens, P. Th. A. (Netherlands Red Cross Blood Transfusion Service, Amsterdam). Ser. Haematol., 11: 229-34(1965).

After description of a method for a reproducible lymphocyte transformation test, a discussion was presented on levels of radiation required to inhibit lymphocyte reactivity. The lack of effect of ionizing radiation on the rate of mitosis in the lymphocyte cultures was discussed. The radiosensitivity of the homograft reaction of lymphoid cells was well known and was determined accurately by use of the killing effect in irradiated mice (graft-vs-host reaction). A D_{37} value of ~100 R was found, assuming that this activity was related to the homograft reaction. There were many possibilities to explain the failure to find an effect of doses up to 400 R. One possibility was that although irradiation might prevent 50% of the cells from dividing, the amount of stimulating substance that became available from disintegrating irradiated cells compensated for that effect. Much more qualitative work was needed before it would be possible to evaluate the effect of irradiation properly, in particular in experiments with graded mixtures of irradiated cells. There seemed to be no reason to expect that all cellular functions were equally sensitive to the action of x rays. In particular, DNA synthesis could be very insensitive, although other more complicated cell functions might be highly sensitive. (BBB)

14925 ABSORPTION OF ^{239}Pu THROUGH THE SKIN AND FROM THE SUBCUTANEOUS TISSUE OF YOUNG PIGS. Buldakov, L. A.; Nifatov, A. P.; Tolochkova, N. M.; Burov, N. I. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 591-601(1967). (In Russian).

Two-month-old pigs (53) weighing 7.7 to 13.45 kg were used. Three received plutonium citrate intravenously; 16 received plutonium citrate applied on shaven and degreased skin near the spine, 470 to 1127 microcuries, pH = 6.5; 34 received plutonium subcutaneously (17 in the form of a citrate complex at pH 6.5 and 17 in the form of ammonium plutoniumpentacarbonate in 10% carbonate at a pH of about 8). The plutonium was applied to two sections of skin, one for radiometry and one for histoautoradiograms. The plutonium did not exceed 1 microcurie per injection and the volume of the solution was 0.5 ml. The results showed that 0.347% of the applied plutonium citrate is absorbed in six days, of which 0.183% was absorbed in the first days. Its distribution within the organism is similar to that after internal administration—81% in the skeleton and not more than 18.5% in the liver. (JPRS)

14926 TRANSFER OF ^{90}Sr FROM MOTHER TO OFFSPRING IN A CHRONIC EXPERIMENT. Shvedov, V. L. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 602-4(1967). (In Russian).

Eighty-five female white rats four months old received ^{90}Sr (0.5 microcuries/day) in three groups: for 90 days before labor, from the start of pregnancy (20 days) and after labor. The ^{90}Sr content in the offspring of the first two groups was 3.5% of that of the mothers and the content per g of body weight was the same in the mothers and offspring of each group; this indicates that the fetal requirement for calcium is met mainly from the maternal skeleton and not from the ration. The data also indicated that the mother's skeleton is the main source during lactation. (JPRS)

14927 SOME ASPECTS OF THE BEHAVIOR OF ^{137}Cs. Zapol'skaya, N. A.; Smorodintseva, G. I.; Mikhailov, V. G.

(Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya, 7: 605-8(1967). (In Russian).

Forty-eight male white rats weighing 165 ± 7 g were administered 30 microcuries each of cesium chloride perorally. One group received only the ^{137}Cs; the other received 5 units of ACTH each intraperitoneally for 3 days and the ^{137}Cs was administered four hours after the last ACTH injection. Tissues were examined 1, 5, 10, 40, and 60 days later and the distribution of ^{137}Cs in the organism was determined. The ACTH had no apparent influence on the behavior of the ^{137}Cs. In the early periods, ^{137}Cs is in the intercellular fluid in an ionic state and only later is it included in the cellular elements and bonded with proteins. (JPRS)

14928 PROTEINS (ANTIBODIES) REACTING SPECIFICALLY WITH DNA DAMAGED BY ULTRAVIOLET RADIATION. Podgorodnichenko, V. K.; Poverenny, A. M. (Inst. of Medical Radiobiology, Obninsk, USSR). Mol. Biol., 1: 483-7(July-Aug. 1967). (In Russian).

The effects of various doses of uv radiation (254 nm) on the ability of DNA to precipitate antibody to uv-irradiated DNA were studied. The DNA used to prepare antibodies in rabbits was irradiated with doses varying from 3×10^5 to 10^6 erg/mm^2 in 0.01M NaCl solution. The antibodies formed after immunization with DNA irradiated with uv in this dose-range did not react with the control (unirradiated, native) DNA, denatured DNA, or single-stranded DNA. Ultraviolet-irradiated RNA (3×10^5 erg/mm^2) did not precipitate antibodies to irradiated DNA (3×10^5 erg/mm^2), but an antigen-antibody reaction was noted with DNA, as antigen, irradiated at sufficient doses. Thus, antibody induced by DNA irradiated at a dose of 10^6 erg/mm^2 began to react with DNA irradiated at 3×10^5 erg/mm^2. (BBB)

14929 CELLULAR IMMUNITY: AN EXPRESSION OF ANTIGENIC RECOGNITION. Moeller, G.; Moeller, E. (Karolinska Institutet, Stockholm). Ser. Haematol., 11: 235-9(1965).

Normal and neoplastic fibroblasts were found to be killed by close contact with nonimmune and x-irradiated allogeneic or semi-isogeneic lymphoid cells. The possibility that conventional immunological reactions carried out by the lymphoid cells were responsible for the observed effects was shown to be unlikely by various experiments. It was demonstrated that x-irradiated (1500 to 3000 R) lymphoid cells killed fibroblasts as efficiently as control cells. This dose of x rays was sufficiently high to prevent completely the phytohemagglutinin (PHA)-induced stimulation of cell division, as determined by ^{14}C-thymidine incorporation. Normal lymphoid cells were mixed in vitro with equal numbers (10^7) of x-irradiated syngeneic and allogeneic lymphoid cells, respectively, in the presence and absence of PHA. It was regularly found that mixtures of antigenically incompatible cells resulted in marked stimulation of DNA synthesis as compared to syngeneic mixtures. Repeated experiments showed that nonimmune parental lymphoid cells, aggregated to F_1 hybrid neoplastic or embryonic target cells by PHA, destroyed the targets within 24 to 48 hr. Irradiation did not detectably influence the efficiency of the lymphoid cells. Spleen cells from mice repeatedly immunized against sheep red cells were mixed in vitro with nonimmune syngeneic and allogeneic (or semi-isogeneic) x-irradiated lymphoid cells in a ratio of 1:1 to 1:5 and PHA was added to cause efficient aggregation. The mixtures were injected into irradiated (300 R) hosts syngeneic with the nonirradiated antibody-forming spleen cells. Hemolytic and agglutinating antibody titers against sheep red cells were higher in mice that received a mixture of anti-sheep spleen cells and x-irradiated allogeneic cells than in those that were given syngeneic mixtures. Presumably the antibody-producing cells were stimulated by the contact with the foreign antigens of the x-irradiated allogeneic cells, in analogy with the results in vitro. It was concluded that target cell confrontation with foreign cellular isoantigens caused cell death and the phenomenon was termed antigeneic recognition. (BBB)

14930 ACTION SPECTRA FOR MITOTIC SPINDLE DESTRUCTION AND ANAPHASE DELAY FOLLOWING IRRADIATION OF THE CYTOPLASM WITH AN ULTRAVIOLET MICROBEAM. Brown, Darrell Q. (Univ. of Tennessee, Knoxville); Zirkle, Raymond E. Photochem. Photobiol., 6: 817-28(Nov. 1967).

Because uv microbeam irradiation of cytoplasm adjacent to the mitotic spindle caused the spindle to diminish or disappear, it was postulated that this effect was mediated by a spindle poison produced photochemically from a cytoplasmic precursor. In this report, a microbeam action spectrum for this effect was obtained to aid in the identification of these mediator materials. A small portion of the cytoplasm of Ambystoma (salamander) tissue culture cells was irradiated in early metaphase with uv microbeams of various wavelengths and intensities but of the same diameter (8 μ). Spindle destruction was scored by observing diminution of its image as seen with a polarization microscope. In addition, the time of anaphase was recorded so that an action spectrum for anaphase delay was also obtained. These two action spectra were similar and were nearly parallel to the absorption spectrum of a tyrosine-containing protein. Some proteins that might mediate this effect were considered. (BBB)

14931 A COMPUTERIZED SYSTEM TO AID IN THE PROCESSING OF RADIOASSAY DATA. Moore, Richard (American National Red Cross, Washington, D. C.). Curr. Mod. Biol., 1: 204-13(Aug. 1967).

A computer program was developed to assist with experiments on transport across human erythrocyte membranes. These experiments utilized radioisotopes to measure amounts of an amino acid inside and outside red blood cells. A model which simulated the system was introduced for calculation from these data and the analysis of transport kinetics. A 2-channel β spectrometer was coupled to a so-called time-sharing computer for reduction of the radioassay data. The β spectrometer was modified to punch ASCII code on paper tape, which the computer was programmed to accept. A family of programs was written which rearranged the data, calculated several kinds of results, and produced point plots of certain values. In the utilization of computers to process radioassay data, it was demonstrated that time-sharing had several advantages over batch-processing. However, the time-sharing method had specific limitations that were discussed. (BBB)

14932 DETERMINATION OF THE ELECTROPHORETIC MOBILITY OF FOOT-AND-MOUTH DISEASE VIRUS IN AGAR GEL BY MEASURING THE RADIOACTIVITY. Matthaeus, W. (Bundesforschungsanstalt fuer Viruskrankheiten der Tiere, Tuebingen, Ger.). Zentralbl. Bakteriol. Parasitenk., Abt. 1 Orig., 204: 161-5(Aug. 1967). (In German).

A method for incorporating ^{32}P in foot-and-mouth disease virus and using the ^{32}P in the virus to measure its mobility is described. Tissue culture adapted strains of the virus (A_4 West Germany, C. Riems, and O. Hannover strains) were labeled with ^{32}P prior to purification and concentration procedures. These included low-speed centrifugation, precipitation by ammonium sulfate, treatment with Arcton 113/2, gel filtration with Sephadex G-25 and 0.01M phosphate buffer containing sodium chloride (each strain required a different content of salt), and shaking with DEAE-Sephadex A-50 using the specific buffer. Only small amounts of proteins and radioactive cell components could be detected in the preparations. The agar-gel electrophorograms, as determined by measuring the radioactivity or autoradiography on x-ray film, revealed only one radioactive band that was homogeneous and specific for each virus strain, and corresponded to the maximum infectivity tested. (BBB)

14933 FIXATION OF ^{65}Zn IN SOME CALCAREOUS SOILS AND ITS AVAILABILITY TO TOMATO PLANTS. Navrot, J.; Jacoby, B.; Ravikovitch, S. (Hebrew Univ., Rehovot, Israel). Plant Soil, 27: 141-7(Aug. 1967).

Binding of ^{65}Zn in two calcareous surface soils was examined, namely in a loess soil derived from desert dust material originating partly from carbonaceous rocks, and a rendzina formed on marl. Marmande tomatoes (Lycopersicum esculentum) were used as test plants to determine ^{65}Zn availability. Zinc-65 fixation was very rapid and almost complete in both soils. Most of the ^{65}Zn was fixed in the uppermost layer of soil columns; ^{65}Zn penetration was somewhat deeper into the loess with the lower $CaCO_3$ content than into the rendzina. Zinc-65 availability was, however, higher in the rendzina than in the loess soil either determined by uptake by tomato plants or by extractability. Possible reasons for the differences in ^{65}Zn availability in the two calcareous soils were discussed in terms of the different solubility of ^{65}Zn in the two calcareous soil types. The cause could be related to differences in the nature of fixed Zn formed, perhaps in relation to the specific surface of $ZnCO_3$ particles. (BBB)

14934 THE SOLUBILITY OF ^{133}Xe IN VARIOUS MUSCLES IN MAN. Veall, N. (Guy's Hospital, London). Scand. J. Clin. Lab. Invest., 19: Suppl. 99, 13(1967).

The in vitro method described previously by Veall & Mallett (Phys. Med. Biol., 10: 375(1965)) was elaborated to permit measurement of the relative solubility of ^{133}Xe in human muscle at 37°C. Preliminary data for muscle free from adipose tissue gave an average value for λ of 0.77 (range 0.73 to 0.81) for a hematocrit of 40%. (BBB)

14935 THE LONG-TERM SKELETAL RETENTION AND RECIRCULATION OF ^{85}Sr IN MAN. Smith, D. A. (Western Infirmary, Glasgow); Speirs, C. F.; Shimmins, J. Calcified Tissue Res., 1: 144-52(Aug. 15, 1967).

The retention of ^{85}Sr for periods up to 150 days was followed in eight patients with osteoporosis, two with Paget's disease, and two

with chronic renal failure. The rate of decrease of whole-body retention of isotope did not represent the rate of loss from the skeleton, as isotope returning from bone went into a rapidly exchanging pool (REP) composed of extracellular fluid, soft tissue, and bone, and from the pool was in part lost in urine, feces, and sweat, and in part returned to bone. The rate of loss of isotope from bone into the REP before recycling occurred was determined. This rate of loss was found to be greater in Paget's disease than in osteoporosis and in chronic renal failure, the last two being nearly equal. By applying the calculation to the data of Adams and Carr it was found that in microphthalmic mice, that have very low rates of bone destruction, the rate of return of isotope was in fact greater than in normal mice. This supported previous conclusions that the rate of loss of ^{85}Sr was largely due to heterionic exchange and not to resorption of labeled bone. (BBB)

14936 IN VITRO STUDIES ON THE THYROID GLAND: THE UPTAKE OF RADIOIODINE BY DOGFISH THYROID TISSUE. Hyder, M. (Univ. Coll., Nairobi, Kenya). Physiol. Bohemoslov., 16: 379-86(1967).

Elasmobranch thyroid tissue from both species of dogfish used, namely, Scyliorhinus caniculus and Squalus acanthias, showed a consistent affinity for the radioiodine in the medium. The degree of ^{131}I uptake varied and the two major factors that contributed to this variation were the amount of the tissue per tube and the degree of subdivision to which the tissue was subjected prior to the incubation. There was a clear and unmistakable difference of ^{131}I uptake between the killed and unkilled thyroid tissue. Tissue subjected to formalin fumes for 20 min showed virtually no uptake, suggesting that the uptake of radioiodine was a function of living tissue. Both muscle and liver showed little uptake in comparison with thyroid tissue incubated under the same conditions. The results indicated that the radioiodine taken up by the living thyroid tissue was subjected to the pathways of metabolism in vitro similar to those which normally operate in vivo. If this were so, some radioiodine would be protein bound. This was actually found to be the case; some of the radioiodine taken up was converted into protein-bound hormones. Autoradiography showed that the bound iodine was localized in the follicles of the thyroid tissue and in the colloid. The possibilities of using an in vitro technique like this for the development of a satisfactory bioassay method for the detection, localization, and measurement of iodine and possibly also thyroid-stimulating hormones were discussed. (BBB)

14937 AMBER MUTANTS OF BACTERIOPHAGE T3 AND T7 DEFECTIVE IN PHAGE-DIRECTED DEOXYRIBONUCLEIC ACID SYNTHESIS. Hausmann, R.; Gomez, Beatriz (Southwest Center for Advanced Studies, Dallas, Tex.). J. Virol., 1: 779-92(Aug. 1967).

Amber mutants of the related phages T3 and T7 were isolated and tested for their ability to restore (as the wild type does) thymidine incorporation in uv-irradiated, uv-sensitive, nonpermissive host bacteria (Escherichia coli B_{5-1}). Most amber mutants had this ability. However, in both T3 and T7, mutants unable to promote thymidine incorporation under these conditions were found and classified into two well-defined complementation groups: T3DO-A and T3DO-B, T7DO-A and T7DO-B. Infection of B_{5-1} cells with representatives of groups DO-A had the following characteristics: phage-directed uridine uptake in uv-irradiated cells was reduced to less than 20% of normal; breakdown of host DNA was delayed and incomplete; no serum-blocking antigens appeared; no cell lysis occurred; and the ability to exclude the heterologous wild type was impaired. Amber mutants of the DO-B groups, infecting B_{5-1}, were able to: promote an efficient phage-directed uridine uptake in uv-irradiated cells; bring about rapid breakdown of host DNA; synthesize serum-blocking antigens; lyse the host cells, generally after the normal latent period; and exclude efficiently the heterologous wild type. Although physiological similarities between the respective DO-A mutants or DO-B mutants of T3 and T7 were evident, no physiological cross-complementation occurred, and genetic crosses gave no evidence of genetic homologies between groups of T3 and T7. (BBB)

14938 FREE-RADICAL DISTRIBUTIONS IN SEVERAL GAMMA-IRRADIATED DRY PROTEINS AS DETERMINED BY THE FREE-RADICAL INTERCEPTOR TECHNIQUE. White, Frederick H. Jr.; Riesz, Peter; Kon, Hideo (National Inst. of Health, Bethesda, Md.). Radiat. Res., 32: 744-59(1967).

Free-radical distributions in several dry, γ-irradiated proteins were compared by means of the free-radical interceptor technique, which involves reaction of carbon free radicals with tritiated hydrogen sulfide to form carbon–tritium bonds within the protein. Subsequent hydrolysis, amino acid analysis, and counting then revealed the tritium distribution among the amino acids which was taken as an indicator of the free-radical distribution. A comparison of the tritium distributions among the proteins studied indicates many similarities, among which are high specific activities for methionine and proline, with relatively low activities for many other residues (for example, glycine, alanine, valine, isoleucine, and leucine). Despite this general pattern, many differences in labeling were found. Lysine, for example, was the most heavily labeled amino acid for ribonuclease. For lysozyme, lysine and methionine were the most radioactive, with nearly equal specific activities. Methionine was the most active amino acid for chymotrypsinogen and gelatin, as were proline for insulin and histidine for myoglobin. Destruction of protein conformation prior to irradiation resulted in tritium distributions that were quite different from those of the corresponding native proteins, characterized by higher specific activities for most of the hydrophobic residues, as well as for threonine and serine, while those of lysine and histidine were markedly lower. Further, there was a greater similarity among the tritium distributions of the reduced proteins than for their parent proteins. The results indicate conformation as a major determinant in the free-radical distribution of the irradiated native protein. (auth)

14939 TRANSFER OF IMMUNITY TO ANCYLOSTOMA CANINUM INFECTION IN PUPS BY SERUM AND LYMPHOID CELLS. Miller, T. A. (Glasgow Univ., Bearsden, Scotland). Immunology, 12: 231-41(Feb. 1967).

Vaccination of dogs of various ages by subcutaneous inoculation of two doses of 40-KR x-irradiated A. caninum larvae was effective in conferring protection against the pathogenesis of challenge infection and against the establishment of adult hookworms from challenge inocula of normal A. caninum larvae. Vaccination by subcutaneous inoculation of irradiated larvae was more effective than oral vaccination with irradiated larvae, oral vaccination with normal larvae, and subcutaneous vaccination with normal larvae. Between 85 and 95% of 40-KR irradiated larvae failed to complete migration in susceptible pups after subcutaneous inoculation while only 15 to 30% of normal larvae failed to reach the intestine. Experiments demonstrated that the conferred immunity could be transferred to susceptible pups by serum and/or lymph node preparations. The immunity of recipient pups was demonstrated by a high degree of resistance to the establishment of adult hookworms after challenge inoculation of normal A. caninum larvae. Delayed hypersensitivity was transferred to recipient pups as shown by significant increases in skin thickness 24 to 48 hr after active penetration of hookworm larvae. (BBB)

14940 ESTIMATION OF ORGAN DEPTH BY A DOUBLE ISOTOPE TECHNIQUE. Dolan, Charles T.; Tauxe, W. Newlon (Mayo Clinic, Rochester, Minn.). Bull. Pathol. (Chicago), 8: 45(Feb. 1967).

A new technique was developed to determine the depth at which organs may be located within the body and to quantify radioactivity in these organs accurately. The method utilizes 2 nuclides, such as ^{125}I and ^{131}I, which differ in their energies of disintegration and characteristics of tissue absorption. It was shown that, because of these differences, a ratio of the counts from these 2 nuclides, recorded by a 2-channel pulse-height analyzer, is related inversely to the distance of the organ from the detector. That is, as the distance between the organ and the detector becomes greater, the count ratio $^{125}I/^{131}I$ becomes smaller. After demonstrating this relation, the effects that organ thickness and radioactivity of body background have on the ratio were examined. In a range of 1 to 3.5 cm (thickness of 5 methyl methacrylate phantoms), the ratio changed no greater than 0.3. Radioactivity of body background within the expected in vivo limits had no effect on the ratio. This relation can be used for the accurate quantitation of the renogram. If, for example, o-iodohippurates labeled with ^{125}I and with ^{131}I are given intravenously to a subject, simultaneous renogram recordings of both nuclides can be made with a 2-channel, pulse-height analysis system. From a known ratio-to-distance curve determined by an in-vitro method, kidney depth is ascertained. (BBB)

14941 PROLIFERATION OF MAST CELLS AFTER ANTIGENIC STIMULATION IN ADULT RATS. Miller, J. J.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco). Nature (London), 217: 263-4(Jan. 20, 1968).

In the course of a series of experiments using tritiated thymidine to study long-lived lymphocytes and plasma cells in rat lymph nodes a high percentage of labeled mast cells was frequently found. Since this finding appeared inconsistent with reports that mast cells are stable and only divide slowly, earlier work was re-examined; evidence was found that mast cells were actively produced after antigenic stimuli. The effect of x irradiation, and also certain drugs, on the mast cell labeling index was studied. The index was significantly decreased by x irradiation. It was not known, from labeling index data, whether the decrease indicated radiosensitivity of the labeled long-lived mast cells, or proliferation of new unlabeled cells. The drugs employed did not change the labeling index. (UK)

14942 THE ASSOCIATION OF CAFFEINE RESISTANCE AND ULTRAVIOLET SENSITIVITY IN ESCHERICHIA COLI: A SIMPLE METHOD OF SELECTING RADIATION SENSITIVE AND RADIATION RESISTANT MUTANTS. Grigg, G. W. (CSIRO, Epping, New South Wales). Mutat. Res., 4: 553-7(Sept.-Oct. 1967).

Mutants of Escherichia coli strains B, B/r and 15, selected for their resistance to caffeine-death, were found to have altered sensitivities to the lethal effects of ultraviolet radiation. Of a series of 17 Caf^r mutants of E. coli B studied, 13 were uv sensitive and four uv resistant. The two groups differed in their response to 400 to 700 erg/mm^2 of uv by a factor of about 10^7. It was suggested that selection for caffeine resistance is a simple and convenient way to collect some classes of mutants altered in one or another step of the excision-repair pathway. (auth)

14943 DNA SYNTHESIS AFTER ULTRAVIOLET LIGHT IRRADIATION IN UV-SENSITIVE MUTANTS OF BACILLUS SUBTILIS. Okubo, Shunzo; Nakayama, Hiroaki (Kyushu Univ., Fukuoka). Mutat. Res., 4: 533-41(Sept.-Oct. 1967).

In uv-sensitive, host cell reactivation negative mutants of Bacillus subtilis, DNA breakdown after uv exposure and recovery of DNA synthesis prevented by irradiation were not observed as in similar mutants of Escherichia coli. On the other hand, uv-sensitive, transformation-deficient mutants regained their ability to synthesize DNA after uv exposure, even when the surviving fraction was low. This result formed a contrast to that obtained with the recombination-deficient mutant of E. coli. The DNA formed in the mutant after uv exposure had the same transforming activity as the DNA of the wild type. No abnormality on the DNA molecule of the mutant could be detected by transformation. It could not be confirmed by transformation that the origin of chromosome replication is the only new site of DNA synthesis after uv irradiation. (auth)

14944 IMMUNIZATION OF GUINEA PIGS WITH FOOT-AND-MOUTH DISEASE VIRUS SUBJECTED TO PHOTODYNAMIC INACTIVATION. Espensen, L. (State Veterinary Inst. for Virus Research, Lindholm, Denmark). Acta Pathol. Microbiol. Scand., 68: 585-91(1966).

Use of visible and uv radiation to inactivate foot-and-mouth disease virus and produce a vaccine is described. The type C FDMV strain was inactivated photodynamically with a proflavin (3,6-diamino acridine). This virus was tested for its immunizing effect on guinea pigs and found to be more effective than after inactivation by uv light. Irradiation was carried out after the virus-proflavin mixture was allowed to stand for 24 hr at 4°C. Irradiation by a fluorescent lamp in the absence of proflavin caused no significant change in the infectious titer. Complete inactivation of virus in 20 min or less was obtained by irradiation with a fluorescent lamp, and the rate of inactivation during irradiation with uv light alone was not significantly different from that caused by uv light plus proflavin. When suspensions of foot-and-mouth disease virus to which proflavin had been added were irradiated with visible light until the virus had lost its infecting capacity in calf kidney tissue cultures, vaccination of guinea pigs with these suspensions resulted in good immunity. However, uv light caused the virus to lose not only its infectivity but its immunizing effect as well. (BBB)

14945 ON THE EQUILIBRIUM BETWEEN THE STEREOISOMERS OF SOME CINNAMIC ACID DERIVATIVES IN RELATION TO THE MOLAR CONCENTRATIONS AND THEIR QUANTITATIVE SPECTROPHOTOMETRIC MEASUREMENT IN PLANT ANALYSIS. Kahnt, G. (Landwirtschaftliche Hochschule, Stuttgart-Hohenheim, Ger.). Biol. Zentralbl., 85: 545-54(1966). (In German).

The effect of uv radiation of various wavelengths on some plant constituents was studied. After uv irradiation of the trans forms of p-coumaric acid, caffeic acid, ferulic acid, sinapic acid, and chlorogenic acid, a trans-cis equilibrium was detected, which was dependent on the nature of the compound, the solvent, and the molar concentration. The extinction of the cis isomer was nearly 50 to 55% that of the trans isomer. Trans-to-cis conversion was only affected after irradiation by uv light of wavelengths shorter than 350 nm. The significance of the finding of isomerization by uv radiation of the four phenylpropane derivatives of cinnamic acid studied here (usually found in nature as glycosides or esters) to plant physiology is discussed. (BBB)

14946 HIGH RADIOSENSITIVITY OF THE ALLOSTERIC CENTER OF ENZYMES. Kuzin, A. M.; Ivanitskaya, E. A. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 628-9(1967). (In Russian).

The activity of aspartate kinase was studied on the basis of its ability to transform aspartate into aspartophosphate, the percentage of inhibition in the presence of threonine and, in the same system, the suppression of the activity of aspartate kinase after irradiation with 20 and 40 kR and the percentage of retroinhibition in the presence of threonine of the irradiated enzyme. Threonine inhibited the unirradiated enzyme's activity by about 40%. After irradiation at 40 kR the activity was inhibited by only 30% but the threonine completely lost its ability to retroinhibit the enzyme; this evidently is connected with inactivation of the allosteric center. At a dose of 20 kR the activity was inhibited only 20% but the addition of threonine caused no inhibition, that is, the allosteric center continued to function normally. (JPRS)

14947 UPPER INTESTINAL TRACT INFECTION PRODUCED BY E. ACERVULINA AND ABSORPTION OF ^{65}Zn AND ^{131}I-LABELED OLEIC ACID. Turk, D. E.; Stephens, J. F. (Clemson Univ., S. C.). J. Nutr., 93: 161-5(Oct. 1967).

At intervals after inoculation with Eimeria acervulina, 4-week-old chickens were orally administered 50 μCi of ^{65}Zn absorbed on sucrose, and concurrently 20 μCi of ^{131}I-labeled oleic acid. This protozoan parasite attacks the anterior portion of the chicken intestine, producing intestinal damage. The infection caused growth retardation on the seventh through tenth days postinoculation and visible damage to the lining of the upper one-third of the intestinal tract during the period from 5 to 10 days postinoculation. Increased absorption of orally administered ^{65}Zn and ^{131}I-labeled oleic acid occurred on day 1 and from days 14 through 21 postinoculation, whereas greatly decreased absorption of both radioisotopes was observed on days 5 through 10 postinoculation. Both ^{131}I-oleic acid and ^{65}Zn absorptions were severely and equally depressed by E. acervulina infection. This was contrasted with E. nectrix infection in which ^{65}Zn absorption was much more severely affected than ^{131}I-oleic acid absorption. (BBB)

14948 ON THE EFFECT OF VARIOUS SYMPATHOMIMETIC AMINES ON CONTRACTILITY AND ^{45}Ca UPTAKE OF ISOLATED GUINEA PIG AURICLES. Reuter, H.; Wollert, U. (Univ., Mainz). Arch. Pharmakol. Exp. Pathol., 258: 288-96(Sept. 15, 1967). (In German).

The influence of sympathomimetic amines on contractility and ^{45}Ca uptake of isolated, electrically stimulated left auricles of guinea pigs was investigated. All sympathomimetic amines, except methoxamine, exerted positive inotropic effects. The effect of (–)-adrenaline on contractility was about 20 times stronger than that of (+)-adrenaline, whereas (–)- and (+)-synephrine were equally effective in the concentration range 10^{-7} to 10^{-5} g/ml. Depletion of noradrenaline stores by pretreatment of the animals with reserpine greatly reduced the action of (+)-synephrine but not that of (–)-synephrine. It was concluded that (–)-synephrine acts directly while the effect of (+)-synephrine is mainly an indirect one. Under the conditions employed there was a marked parallel influence of all the sympathomimetic amines investigated on contractility and ^{45}Ca uptake of isolated guinea pig auricles. Therefore, the increase in Ca influx during excitation appeared to be responsible for the positive inotropic effect of sympathomimetic amines. (BBB)

14949 EFFECT OF PROPYLTHIOURACIL ON THE IODINATION AND MATURATION OF RAT THYROGLOBULIN. Simon, Claude; Roques, Marie; Torresani, Janine; Lissitzky, Serge (Faculte de Medecine et de Pharmacie, Marseille). Acta Endocrinol., 53: 271-85(Oct. 1966).

Radioiodine metabolism was studied in rats treated with an antithyroid drug. Experiments were performed on rats in isotopic equilibrium with ^{125}I, and treated with propylthiouracil or propylthiouracil or propylthiouracil and triiodothyronine and also given a single injection of ^{131}I. The results demonstrated that the appearance of radioiodinated thyroglobulin monomer was due to the dissociation of labile iodinated thyroglobulin dimer and that it appeared more readily if the dimer was poorly iodinated. Uniodinated thyroglobulin dimer was the most probable substrate for radioiodination in vivo. Maturation of thyroglobulin dimer (as shown by an increase of the sedimentation constant from 16 to 17 to 19) was accompanied by increasing amounts of ^{131}I in the molecule. It was not possible to determine if radioiodination and iodothyronine formation were the cause or the consequence of thyroglobulin dimer maturation. Propylthiouracil probably inhibited thyroglobulin maturation by decreasing iodine organification. (BBB)

14950 THE EFFECT OF IRRADIATION BY IONIZING RADIATION ON MILK ENZYMES. II. IRRADIATION EFFECTS ON PEROXIDASE AND CATALASE ACTIVITIES IN MILK. Tsugo, Tomokichi; Hayashi, Toshio (Tokyo Univ.). Nippon Chikusangaku Kaiho, 33: 121-4(June 1962). (In Japanese).

Effects of ^{60}Co γ radiation on some enzyme activities in milk under various conditions were examined. It was found that the inactivation of milk peroxidase by ionizing irradiation depended on the amount of oxygen present. About 96% of the peroxidase activity was inactivated by 2.4-MR under relatively aerobic con-

ditions. On the other hand, only 82% of this activity was lost after 3.43-MR irradiation under relatively anaerobic conditions. Therefore, the more oxygen present, the less the radiation dose needed for inactivation of peroxidase. Contrary to results with phosphatase, it was observed in the inactivation of milk peroxidase that there was no significant difference between whole milk and skim milk. This finding could have been due to the fact that peroxidase was present in the lactalbumin fraction of milk and, therefore, had no association with the fat fraction of milk, as in the case of phosphatase. It was found that 94.3% of the milk catalase was inactivated by 18.5-MR irradiation. Therefore, milk catalase was much more radiation resistant than milk peroxidase. Milk peroxidase and milk catalase had greater heat-resistance than phosphatase, even though they (particularly milk peroxidase when oxygen was present) were more radiosensitive than phosphatase. This could be related to the fact that they were both oxidation-reduction enzymes. (BBB)

14951 BREAKDOWN OF DNA FOLLOWING EXPOSURE TO COSMIC RADIATION AT HIGH ALTITUDE. **Ong, S. G. (Inst. of Epidemiology and Microbiology, Peking); Chang, F. H. Hua Hsueh Tung Pao, 17: 36-7(Jan. 15, 1966).**

Effects of exposing thymus DNA solution directly to cosmic radiation at Chingliangchiao (2400 m altitude), Wutai Shan, Shansi, Lat. 39°N for 86 days are reported. The viscosity of DNA kept at high altitude was greatly reduced. The reduced viscosity and the significantly smaller slope of the viscosity vs concentration curve of high altitude DNA suggested a breakdown of the rod-like particles. The uv absorption curves of high altitude and sea-level DNA had a similar shape; however, the optical density of high altitude DNA was markedly increased below 275 mμ, especially in the specific region of 260 mμ. The maximum of high altitude DNA was shifted to the shorter wavelength and above 275 mμ the optical density was lower than that of sea-level DNA. This again suggested a breakdown of DNA and of the hydrogen bonds between the bases in the DNA molecule. It was shown that the percentage of tumors in mice following an injection of 20-methylcholanthrene was significantly greater at 2400 m than at sea-level. Increased production of a specific DNA was postulated as being responsible for the development of tumors. The significant increase of tumors at high altitude was explained by a greater production of DNA as compared with that at sea-level. These results were correlated with carcinogenesis experiments conducted at the same site. (BBB)

14952 MAIN STEPS AND DIRECTIONS IN STUDIES ON RADIATION DAMAGE OF THE CELL IN THE SOVIET UNION. **Paribok, V. P.; Pereverzev, A. E. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1213-24(Oct. 1967). (In Russian).**

The main steps and directions of development of cell radiobiology in the USSR have been considered (1917–1967). (auth)

14953 SIMPLIFIED BILATERAL DIFFERENTIAL FUNCTION STUDIES IN HYPERTENSIVE PATIENTS UTILIZING RADIOACTIVE CLEARANCE TECHNIQUES. **de Palma, John R.; Cutler, Ralph E. (King County Hospital, Seattle). J. Urol., 97: 559-66(Apr. 1967).**

Methods were developed for use of ^{57}Co-labeled vitamin B_{12} and ^{125}I-hippuran to measure glomerular filtration rate (GFR) and effective renal plasma flow (ERPF), respectively. Simultaneous doses (0.01 μCi/Kg ^{57}Co and 0.2 μCi/Kg ^{125}I) were injected intravenously. Radioactivity of samples of plasma and urine was measured in a well-type scintillation counter with a 2 in NaI crystal and a dual-channel spectrometer. Iodine-125 and ^{57}Co were easily counted by pulse height analysis, using a 20 to 40 keV window for ^{125}I and a 75 to 250 keV window for ^{57}Co. With this arrangement, less than 3% of the total ^{57}Co counts were recorded in the ^{125}I window and less than 0.1% of the total ^{125}I counts were recorded in the ^{57}Co window. Simultaneous determination of GFR and ERPF using ^{57}Co-vitamin B_{12} and ^{125}I-hippuran could be accomplished rapidly and accurately. This technique necessitated dialyzing the plasma for 24 hr to indirectly obtain the free fraction of ^{57}Co-vitamin B_{12} and ^{125}I-hippuran. However use of an estimate of 15% binding of ^{57}Co-vitamin B_{12} and 5% ^{131}I-hippuran to obtain the free plasma fractions of these substances allowed the calculation of data to within 95% of the actual clearances. (BBB)

14954 THE BEHAVIOR OF ^{239}Pu IN RATS AFTER A SINGLE INHALATION OF SOME OF ITS CHEMICAL COMPOUNDS. **Lyubchanskii, E. R. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 541-7(1967). (In Russian).**

Aerosols of the following Pu compounds were inhaled for 20 minutes by 591 rats: plutonium citrate, sodium plutonyltriacetate, ammonium plutonium pentacarbonate in 10% ammonium carbonate, and aqueous ammonium plutonium pentacarbonate. It was found that the initial deposition of ^{239}Pu (28.6% of the intake) does not depend on its chemical form and concentration in the inspired air. The soluble compounds are deposited mainly in the lungs and skeleton. Pu-239 is excreted from the lungs in 1–256 days with two half-times of excretion, 15.5 (13.3–18.1) days (34–64%) and 175 (122–212) days (8.76–23.5%). Regardless of the form, one month after inhalation ^{239}Pu is uniformly distributed in the lungs mainly in the form of "stars." Most of the absorbed ^{239}Pu is deposited in the skeleton, where it does not exceed 9–30%, and 4.1–7% in the liver. (JPRS)

14955 THE INFLUENCE OF IONIZING RADIATION ON THE MACROMOLECULAR ORGANIZATION OF DNA AND DNP. **Tseitlin, P. I.; Ryabchenko, N. I.; Gorin, A. I.; Tronov, V. A.; Sklobovskaya, M. V.; Ivanik, B. P. (Inst. of Experimental Biology, Moscow. Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 658-69(1967). (In Russian).**

The article surveys and discusses in detail the conclusions drawn from investigations of the effect of ionizing radiation on DNA and DNP in recent decades by various investigators and presents the results of numerous experiments on various aspects of the question: comparison of the radiosensitivity of dry DNA and DNA irradiated in organs under conditions where the influence of metabolic processes and direct influence on the radiosensitivity of the DNA were excluded; study of dispersion of the optical rotation of DNA; study of the variation in optical activity of DNA as a function of the percentage of protein; comparison of the specific rotation of DNA, DNP, and histone as a function of temperature, study of curves of the dispersion of optical rotation of DNP in saline concentrations leading to dissociation of the complex, etc. (JPRS)

14956 GRAFT COPOLYMERIZATION INVESTIGATION OF FREE RADICAL REACTIONS IN LIVER CELL ORGANELLES OF IRRADIATED ANIMALS. **Arkhipov, A. S.; Kozlov, Yu. P.; Burlakova, E. F. (Moscow State Univ.). Radiobiologiya, 7: 623-5(1967). (In Russian).**

Unpedigreed male white rats weighing 150 to 170 g received whole-body doses of 200, 650, and 1500 R and 0.25 ml of 6% solution of acrylamide tagged with ^{14}C was administered intraperitoneally immediately at a rate of 10 microcuries/100 g of live weight. Four hours later the animals were decapitated and their livers were removed for examination of the graft copolymerization, which showed that the free radical concentration had increased considerably with increasing dose in liver cells fractions, the largest increase being in the microsomes and mitochondria (JPRS)

14957 EFFECTS OF ACTH AND WHOLE-BODY X IRRADIATION ON THE CONCENTRATIONS OF ENZYMES, NICOTINAMIDE NUCLEOTIDES, AND CYTOCHROMES IN RAT ADRENAL. **Yago, Nagasumi; Omata, Saburo; Kobayashi, Shigeru; Ichii, Shogo (National Inst. of Radiological Sciences, Chiba, Japan). J. Biochem. (Tokyo), 62: 339-44(Sept. 1967).**

Concentrations of DNA, RNA, protein, nicotinamide nucleotides, enzymes, and cytochromes P-450 and b_5 in rat adrenals were determined 24 hr after whole-body x irradiation with a lethal dose (1000 R). At these times, adrenal nuclei showed abnormally high RNA polymerase activity. The concentrations of nicotinamide nucleotides did not change during the experimental periods. In mitochondria, succinic dehydrogenase increased abruptly 74 hr after x irradiation, while $NADH_2$ cytochrome c reductase decreased significantly during the experimental periods. Cytochrome P-450 was increased after 24 hr but significantly decreased after 48 and 72 hr. $NADPH_2$ cytochrome c reductase remained unchanged after 24 and 48 hr but had decreased after 72 hr postirradiation. In microsomes, cytochrome b_5 and $NADH_2$ cytochrome reductase decreased significantly after ACTH injection and x irradiation. Cytochrome P-450 and $NADPH_2$ cytochrome c reductase remained at the control levels, with a temporary increase of the former 24 hr after irradiation. (BBB)

14958 EXPERIENCES OF INTRA-ARTICULAR ADMINISTRATION OF RADIOACTIVE GOLD. **Virkkunen, M.; Krusius, F.-E.; Heiskanen, T. (Kivela Hospital, Helsinki). Acta Rheum. Scand., 13: 81-91(1967).**

Dosimetry and scanning studies were conducted in the course of 156 injections of colloidal ^{198}Au in the knee joint of 90 patients to evaluate the radiation hazard and body distribution of the isotope. Doses up to 10 μCi were used. After the injection, radioactivity counts were made above the treated joint, regional lymph nodes, liver, spleen, and heart, usually after 1 hr. Whole-body scanning was performed in some cases and in two males the gonadal radiation dose was determined after the injection of radiogold into the knee, using dosimeters attached to the scrotum. Activity of the lymph glands and liver reached a maximum one day after radiogold injection, and then decreased as the ^{198}Au decayed. The concentration of the ^{198}Au was estimated by comparing profile scans of the organ and of a phantom, that geometrically resembled the

organ, containing a known amount of radiogold. Tracer doses of 0.5 to 1 μCi were also administered to the large joints to study distribution of radioactivity beyond the joint. Calculated radiation doses to the regional lymph nodes in 27 cases and liver in 19 cases are given. The liver radiation dose was generally insignificant (under 10 rad) or small (10 to 40 rad). It was shown by scanning that in most cases radioactivity spread beyond the joint treated and that there were great individual differences in the degree of diffusion. Clinical observations, based mainly on 85 cases of chronic knee effusion, showed the effect of intraarticular application of radiogold to be favorable in most cases. (BBB)

14959 RENAL LOCALIZATION FOR PERCUTANEOUS BIOPSY BY SCANNING WITH ^{99m}TECHNETIUM–IRON COMPLEX. Forland, Marvin; Gottschalk, Alexander; Spargo, Benjamin H.; Grossman, Burton J. (Univ. of Chicago). Pediatrics, 39: 872-5(June 1967).

Renal scanning with ^{99m}Tc–Fe complex was developed as a rapid and accurate method for kidney localization prior to percutaneous renal biopsy. Kidney tissue was obtained from each of 17 biopsies, in patients ranging from age 3 to 15 yr. The physical properties of this scanning agent make it the optimum isotope in the pediatric age group and radiation exposure with this technique is very low. Scanning is started 1 hr after the intravenous injection of 1 mCi of the ^{99m}Tc–Fe complex. The use of this complex as the scanning agent reduces renal radiation to less than ½ rad. This is about half the radiation received from the radiographic intravenous pyelogram or scanning with ^{197}Hg-chlormerodrin. Mercury-203-chlormerodrin gives 8 to 20 rad per scanning dose. Some physical properties that make ^{99m}Tc an isotope of choice in the pediatric age group include a half life of only 6 hr and a 140 keV γ ray without significant particle emission. In addition, the 140 keV γ ray is penetrating enough to be used with deeper structures like the kidney, but it is readily collimated, permitting high resolution. It is thus possible to administer five to ten times the dose of this nuclide with only one-half to one-tenth the patient irradiation from conventional renal scanning agents. Excretion studies and whole-body counting following intravenous injection of ^{99m}Tc–Fe complex showed a biphasic disappearance curve similar in form to that reported for ^{203}Hg-chlormerodrin; a very rapid initial disappearance rate ($T_{1/2}$, about 1 hr) is followed by a slow phase ($T_{1/2}$, about six days). Renal concentration and urinary excretion, as studied by serial isotope imaging with the Anger camera, is rapid, with maximum uptake at about 1 hr, but there is persistent renal retention, totaling half the total-body dosage, at 24 hr. This presumably reflects concentration in the renal parenchyma and radioautographic studies in animals indicate the localization is cortical. (BBB)

14960 THE BEHAVIOR OF INTRAVAGINALLY APPLIED ^{110m}Ag-LABELED SILVER NITRATE: AN EXPERIMENTAL STUDY IN THE RAT WITH SPECIAL REFERENCE TO SOME HORMONAL AND INFLAMMATORY CONDITIONS. Nyberg, Rune (Univ. of Umea, Sweden). Acta Obstet. Gynecol. Scand., 46: Suppl. 3, 72p (1967).

Measurement of ^{110m}Ag disappearance from the vagina of adult rats, autoradiography of ^{110m}Ag in the vagina, and radiometric analysis of ^{110m}Ag in the blood and certain organs are reported. The rats were hysteroophorectomized. To bring about an estrus phase some rats were treated with 1 μg estradiol. To induce inflammation of the vaginal wall some of the rats in estrus were treated with 15% acetic acid. These different conditions of the vagina were checked by means of smears. The radiosilver nitrate solutions were used in three different concentrations, 10, 7.8, and 3.3%. In rats in estrus, ^{110m}Ag infiltrated only the cornified layer of the epithelium of the vaginal wall and could not be demonstrated by autoradiography later than 30 hr after application. In estrus rats the ^{110m}Ag infiltrated the epithelium and the subepithelial stroma and could be demonstrated there at least four days after application. Disappearance measurements on radiosilver showed that its disappearance through the vaginal wall in estrus was very low or nil. In estrus rats with inflammation of the vaginal wall the disappearance was significantly higher. In the anestrus rats the disappearance rate was even higher. The uptake of ^{110m}Ag in blood, liver, kidney, spleen, brain, pelvic lymph glands, and cecum was very low or nil in the estrus rats. After inflammation it was significantly higher in blood, liver, kidney, and spleen. In anestrus rats the uptake was much higher in blood, liver, spleen, pelvic lymph glands, and cecum. A significant difference in radiosilver absorption between anestrus and estrus animals was thus demonstrated. Inflammation of the vaginal wall caused a significant increase in its absorption as shown by disappearance measurements and radiometric analysis of organs. (BBB)

14961 A COMPARISON BETWEEN THE HANDLING OF IODINE AND TECHNETIUM BY THE THYROID GLAND OF THE RAT. Papadopoulos, S.; MacFarlane, S.; Harden, R. McG. (Western Infirmary, Glasgow). J. Endocrinol., 38: 381-7(Aug. 1967).

Technetium-99m, used as a clinical scanning agent for the thyroid, has many advantages over ^{131}I, and as pertechnetate ion (TcO_4) it is selectively concentrated in the thyroid gland. It was claimed that in contrast to iodide, TcO_4 does not become organically bound in the thyroid. A comparison was made of the handling of $^{99m}TcO_4$ with that of ^{131}I given as iodide in the thyroid gland of the rat and evidence found that after trapping, pertechnetate may be further metabolized. The concentration of $^{99m}TcO_4$/g thyroid at 1 hr was considerably lower than that of ^{131}I, corresponding to 0.08% dose per thyroid. In contrast to ^{131}I, the concentration of $^{99m}TcO_4$/g thyroid at 4 hr was significantly lower than that at 1 hr. The concentration at 24 hr was the same as that at 4 hr. The concentration of $^{99m}TcO_4$ in blood fell more quickly than that of ^{131}I. At 1 hr the values were similar. The fall in concentration of both isotopes in thoracic muscle followed that of the blood. When $KClO_4$ was administered together with the isotopes, the ^{131}I thyroid/blood (T/B) ratio fell to 1.18 and the ^{99m}Tc T/B ratio to 0.74. In methylthiouracil-fed rats the ^{131}I T/B ratio was lower than in controls, and the ^{99m}Tc T/B ratio was higher than controls at 1 and 4 hr, but smaller at 24 hr. The $^{99m}TcO_4$ in the gland was not discharged by $KClO_4$ at 24 hr. (BBB)

14962 XENON ARC VERSUS LASER PHOTOCOAGULATION. L'Esperance, Francis A. Jr. (Presbyterian Medical Center, New York). Int. Ophthalmol. Clin., 6: 335-50(Summer 1966).

Effects of ruby laser (6943 Å) radiation and Xe arc radiation on the retina are described and compared. Because of the monochromaticity of the laser beam, only energy at one wave length was transmitted through the ocular media, and the effect upon various tissues in the eye could be predicted by analyzing the spectrophotometric absorption characteristics of each structure. Absorption (or conversely, transmittance) curves for the tissues along the optical axis indicated that energy at 6943 Å was transmitted with negligible absorption, except in the presence of pigmented matter such as hemoglobin and melanin. Laser radiation at sufficient energies immediately produced a barely perceptible spot of pigment dispersion and chorioretinal edema. If an intraretinal water vapor bubble formed, the retina would be bowed slightly toward the observer, creating a shiny reflection from the internal limiting membrane and anterior wall of the bubble. Laser energy sufficient to cause clotting in the larger retinal vessels was usually accompanied by subsequent vascular necrosis and rupture. The vascular effect produced by laser radiation was dependent upon the proximity of the vessel to the pigment epithelium or melanocytes, and upon the flow rate and absorption characteristics of the enclosed hemoglobin. Laser radiation was effective with the larger vascular lesions if pigment was interspersed intraretinally initially or as a result of repeated low intensity laser bombardments to the vessel area. The proximity of the target area to a concentration of melanocytes was the most important factor in determining the response of any vascular lesion. (BBB)

14963 FINE STRUCTURAL CHANGES IN THE LIVER CELLS OF RATS AT DIFFERENT DEVELOPMENT STAGES AND THE EFFECT OF TOTAL-BODY X IRRADIATION ON THE SUBSTRUCTURE OF THE LIVER IN NEWBORN RATS. Franke, H.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 19: 145-59(1967). (In German).

The ultrastructure of liver cells of 4- and 28-hr-old rats was investigated and compared with that of rat fetuses at day 22 of pregnancy and with that of adult animals. The effect of 400-R total-body x irradiation on the liver of newborn rats both immediately and 24-hr after birth was also examined. Microstructures observed 4 hr after birth were similar to those on day 22 of pregnancy while, within the following 28 hours, they underwent changes, most pronounced in the endoplasmic reticulum and glycogen content. The large deposits of glycogen were exhausted almost completely, whereas the endoplasmic reticulum, initially mostly of vesicular nature, was transformed into ergastoplasmic double membranes. Also, typical networks of the smooth membranes of the endoplasmic reticulum developed. Liver cells with an extremely dense cytoplasm were observed. The substructure described did not change 4 hr after irradiation with 400 R. (BBB)

14964 HORMONAL CHANGES FOLLOWING RADIOHYPOPHYSECTOMY. Wense, Georg (Univ., Vienna). Klin. Med. (Vienna), 21: 430-3(Aug. 1966). (In German).

Within 24 hr after irradiation of the hypophysis by implanted ^{90}Sr increased production of thyrotropic hormone was observed in eight of 10 patients, as demonstrated by T3 (triiodothyronine) tests. Of these patients, four were improved after the operation, but in the other four patients symptoms were unchanged. In

the other two patients thyrotropic hormone production decreased and there were objective or subjective results from the operation. On the seventh day after implantation, regardless of whether the pain symptoms were absent, decreased thyrotropic hormone production could be demonstrated by T3 tests. These phenomena resulted from irradiation damage of the neurohypophyseal pathways or to inflammation or interruption of neural pathways. There was no apparent relation between the freedom from pain that was obtained and the hormonal changes. (BBB)

14965 STUDY OF THE ISOANTIGENS OF TWO RADIATION-INDUCED LYMPHOSARCOMAS. **Mazurek, C.; Estienne, E. (Fondation Curie, Paris). Bull. Cancer, 54: 87-94(Jan.-Mar. 1967). (In French).**

The antigens of two lymphosarcomas induced by x rays in two strains of mice (C57BL and XVII) were studied. The normal sera of C57BL or XVII mice mixed with guinea pig complement had no cytotoxic effect on normal or malignant lymphoid cells. The LS 3762 iso-antiserum prepared in C57BL mice exhibited cytotoxic activity for the cells of radioinduced lymphosarcoma LS 3762 and for AKR thymus cells. This iso-immune serum might correspond to a TL antigen since the thymic cells of AKR mice are TL^+, as well as those of most radioinduced lymphosarcomas of the C57BL strain. When an intravenous injection of LS 3762 antiserum was given simultaneously with a subcutaneous graft of LS 3762 tumor cells, inhibition of the growth of this tumor was noted. This suggests that LS 3762 cells not only possess the TL antigen, but also an X component, comparable to the one found by Gorer in leucosis EL4. The cells of radiolymphosarcoma XVII LS 3073 were sensitive to the LS 3762 isoantiserum, indicating that this lymphosarcoma induced by x radiation in the strain XVII also bears a TL^+ antigen. This was confirmed by the cytotoxic action of LS 3073 iso-antiserum of LS 3073 tumor cells. Furthermore, this antiserum, that displays a very low cytotoxic effect against LS 3762 cells, loses its activity when absorbed on these cells and then tested on LS 3073 cells. Therefore, the antigens of lymphosarcomas LS 3762 probably carry some common antigenic components of the TL type. (BBB)

14966 SEASONALLY INDUCED EFFECT OF CASTRATION ON THE UPTAKE OF RADIOIODIDE (^{131}I) BY THE THYROID OF THE RAT. **Hirschfeld, I.; Kelemen, Agnes; Feszt, G. (Medical and Pharmaceutical Coll., Tirgu-Mures, Romania). Endokrinologie, 51: 19-22(1967). (In German).**

The thyroidal uptake of ^{131}I was measured one month after castration of 80 male and female rats performed in summer or in winter. The ^{131}I in the thyroid was measured over the gland at 1, 2, 24, and 48 hr after its injection. The rats were killed 48 hr after injection and the thyroid concentrations of ^{131}I were measured directly in the glands. Thyroid uptake of ^{131}I was more than doubled in both male and female castrated rats when castration was performed in winter, as compared to castration during the summer. Uptake of ^{131}I decreased by castration during winter. In the rats castrated in summer there was no increased uptake of ^{131}I by the thyroid, as compared to control animals. (BBB)

14967 IODINE TRANSFER AND CONCENTRATION IN THE PREPARTUM COW, FETUS, AND NEONATAL CALF. **Miller, J. K.; Swanson, E. W.; Aschbacher, P. W.; Cragle, R. G. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-GEN-242. J. Dairy Sci., 50: 1301-5(Aug. 1967).**

Radioiodine was administered to 21 pregnant cows seven days before expected parturition. The dose, usually 1 μCi, was given orally as either $Na^{125}I$ or $Na^{131}I$ (both carrier-free). Blood samples were obtained from all cows at 24 hr intervals and external thyroid counts were made. Some cows were slaughtered as parturition appeared imminent, to obtain information on the quantitative aspect of radioiodine in the reproductive tract. Radioiodine concentrations of fetal plasma obtained at slaughter of three cows averaged almost five times the maternal level. Concentration in the amniotic fluid was higher than in fetal plasma, but chorionic fluid radioiodine concentration was midway between maternal and fetal plasma. The inability of the fetus to excrete iodine in urine may be a major factor in the high calf/dam ratios of radioiodine at birth. After birth the disappearance rate of nonbound iodine from the calf exceeded that from the cow in the first two days after dosing. Percentage of the dose retained by thyroids and total radioiodine changes in plasma from birth or day of dosing were similar in dams and calves. (BBB)

14968 THE INCORPORATION OF ^{15}N INTO THE CONSTITUENTS OF THE WHEAT KERNEL. **McConnell, W. D.; Finlayson, A. J. (National Research Council of Canada, Saskatoon). Cereal Chem., 44: 353-8(July 1967).**

When ^{15}N, as ammonium chloride, was administered to maturing wheat plants by injection into the top internode of the plants, it was readily incorporated into kernel components, as indicated by the observation of 4.67 at. % excess ^{15}N in kernel nitrogen. Gluten protein contained 5.00 at. % excess ^{15}N, whereas nitrogen of the salt-soluble kernel proteins contained 4.01 at. % excess ^{15}N. Examination of the ^{15}N distribution among 11 of the gluten amino acids showed differences in the labeling of individual amino acids. Glutamic acid (6.34 at. % excess ^{15}N) was most highly labeled, and proline, an amino acid derived from glutamic acid, contained 5.44 at. % excess ^{15}N. The processes involved in the incorporation of the tracer and the feasibility of utilizing ^{15}N for further study on the formation of cereal protein are discussed. (BBB)

14969 RADIOAUTOGRAPHIC STUDIES OF RETICULAR AND BLAST CELLS IN THE HEMOPOIETIC TISSUES OF THE RAT. **Gaffrey, Ruth W.; Everett, N. B.; Rieke, W. O. (Univ. of Washington, Seattle). Contract AT(45-1)-1377. Anat. Rec., 155: 41-57(May 1966).**

The rates of proliferation and developmental capabilities of reticular cells in the hemopoietic tissues of the rat were studied after administering single and multiple injections of tritiated thymidine. Sublethal ^{60}Co γ irradiation (300 R) was administered to animals previously labeled with ^3H-thymidine to evaluate the role of reticular cells in the repopulation of the marrow. The labeling patterns (per cent label and average grain count) of reticular cells, both phagocytic and nonphagocytic types, were compared with the labeling patterns of blast cells. It was shown that reticular cells proliferate at a slow rate and do not demonstrate the labeling patterns expected of stem cells for the rapidly proliferating myeloblasts, pronormoblasts, lymphoblasts, and megakaryoblasts. The labeling patterns of cells that are generally believed to precede the committed blast cells, the hemocytoblasts, are also discussed and are contrasted with the labeling patterns of the reticular cells. During recovery from sublethal irradiation there was no evidence of differentiation or transformation of labeled reticular cells into blast cells of the various blood cell lines. The labeling patterns of blast cells suggested that most are derived from members of their own group and that any proposed precursors of these blasts would need to be relatively few in number, rapidly proliferating, and highly radiosensitive. (BBB)

14970 QUININE AND CAFFEINE EFFECTS ON ^{45}Ca MOVEMENTS IN FROG SARTORIUS MUSCLE. **Isaacson, Allen; Sandow, Alexander (Inst. for Muscle Disease, Inc., New York). J. Gen. Physiol., 50: 2109-28(Sept. 1967).**

Caffeine (1 mM), that produces only twitch potentiation and not contracture in frog sartorius muscle, increased both the uptake and release of ^{45}Ca in this muscle by about 50%. Quinine increased the rate of release of ^{45}Ca from frog sartorius but not from the Achilles tendon. The thresholds for the quinine effect on ^{45}Ca release and contracture tension were about 0.1 and 0.5 mM, respectively, at pH 7.1. Quinine (2 mM) also doubled the uptake of ^{45}Ca by normally polarized muscle. However, there were variable effects of quinine upon ^{45}Ca uptake in K-depolarized muscle. Quinine (2 mM) increased the Ca, Na, and water content of muscle while decreasing the K content. Both caffeine (1 mM) and quinine (2 mM) released ^{45}Ca from muscles that were washed in Ringer's solution from which Ca was omitted and to which EDTA (5 mM) was added. The results indicate that a basic effect of caffeine and quinine on muscle is to directly release activator Ca^{2+} from the sarcoplasmic reticulum in proportion to the drug concentration. The drugs may also enhance the depolarization-induced Ca release caused by extra K^+ or an action potential. (BBB)

14971 AUTOELIMINATION BY MEANS OF X RAYS: DISTINGUISHING THE CROWDING FACTOR FROM OTHERS IN PREMUNITION CAUSED BY THE MOUSE BILE DUCT CESTODE, HYMENOLEPIS MICROSTOMA. **Tan, D. B.; Jones, A. W. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-1749. Exp. Parasitol., 20: 147-55(Apr. 1967).**

Seven-day-old specimens of H. microstoma were x irradiated in vitro (40 and 20 KR) and implanted into the duodenum of recipient hosts (5 or 10 worms per mouse, respectively). After different intervals of incubation (8 and 20 days) following implantation, the hosts were challenged with cysticercoids by stomach tube (5 or 10 cysticercoids per mouse, respectively). Autopsy a week later revealed that in those hosts receiving the 40 KR-5 worms treatment, with 8 days incubation, the challenge of secondary worms was not affected, although 11% of the primary worms was still present. In those hosts receiving the 20-KR-10 worms treatment, followed by 20 days incubation, both infection rate and length of the challenge worms were greatly reduced as compared to normal controls. Preliminary experiments demonstrated a crowding effect: inhibition of establishment and growth of individual worms by pre-existing and coexisting infections. By autoelimination of pre-existing infections it was shown that host resistance to H. microstoma occurred in the absence of worms. Therefore, a simple crowding effect was distinguished from protective host response to a cestode. (BBB)

14972 DETERMINATION OF THE SELF-ABSORPTION CURVE IN EXPERIMENTS EMPLOYING RADIOCARBON. Kaler, V. L.; Kovalevskaya, R. Z. Microbiology (USSR) (Engl. Transl.), 35: 914-17 (Nov.-Dec. 1966).

Evaluation of self-absorption in measurement of ^{14}C, precipitated as $BaCO_3$ is discussed. According to Sorokin, the sharp maximum on the left-hand side of the self-absorption curve arose as a result of methodological errors. The presence of this maximum on the self-absorption curve presented a fundamental problem. This phenomenon had been described for various β emitters; consequently, the maximum on the self-absorption curve did not arise only as a result of losses when working with very small amounts of precipitates. A theoretical calculation of the solubility product of $BaCO_3$ showed that under experimental conditions no more than 10% of the minimal weight could be lost, that is, the extreme left part of the curve. Along with these considerations, an appropriate experimental check was made of possible errors in two ways: additional precipitation of $BaCO_3$ was carried out on filters with subsequent measurement of the activity of the precipitate obtained; 1 ml of the filtrate was evaporated on filter paper in a 1-cm^2 area and its radioactivity was determined. The percentage of radioactivity of the precipitate on the filter paper relative to the activity of the main precipitate was determined. The largest error, reaching 5 to 10% in individual cases, was observed upon filtering a suspension corresponding to a precipitate weight of 0.1 to 0.2 mg/cm^2, the error dropping to 3 to 4% for 0.3 to 0.4 mg/cm^2. These loss percentages did not noticeably change the shape of the curve. The probable error in extrapolation was less than 5%. The dependence of the height of the maximum on geometric conditions was evidence of the nature of the maximum on the self-absorption curve. The relative height of the maximum decreased with an increase of solid angle, approaching zero at 50% geometry. Thus the maximum on the curve was due to the effect of self-scattering and not to loss of the precipitate. The method of bichromate oxidation of Sorokin was used to determine the content of carbon in the dry matter of algae (Scenedesmus quadricauda) and zooplankton (Daphnia magna and Calanus finmarchicus). The results were compared with determinations of the carbon content by the Duma standard method of microanalysis (dry combustion in a stream of oxygen at high temperatures). In all cases the quantity of carbon determined by the Sorokin method was ~10% lower than with determination by the standard method, that is, ~10% of ^{14}C was not converted to the form $Ba^{14}CO_3$. (BBB)

14973 DIETARY INORGANIC PHOSPHORUS EFFECTS ON RETENTION AND DEPOSITION OF ^{89}Sr. Colvin, L. B.; Creger, C. R.; Ansari, M. N. A.; Allen, W. S.; Couch, J. R. (Texas A and M Univ., College Station). Poultry Sci., 46: 895-9 (July 1967).

The effects of dietary inorganic P on the retention and excretion of injected radiostrontium in growing chicks were studied. Sixty male day-old chicks were fed diets containing 1% total Ca supplemented with 0.1, 0.5, 1.0, and 2.0% inorganic phosphate (IP) supplied as H_3PO_4, and were injected subcutaneously with 4.88 μCi ^{89}Sr ($SrCl_2$). Sp act. of the bone ash was lowest in birds receiving 0.1 and 0.5% IP at each sampling period, the concentration of ^{89}Sr in the bones of these two groups being essentially the same. The ^{89}Sr content of bone tissue was found to be slightly greater at two days following injection of ^{89}Sr in birds receiving 1.0% dietary IP than those receiving 2.0% dietary IP; however, at 7 and 12 days postinjection birds receiving the highest level of dietary IP (2.0%) retained the largest amount of ^{89}Sr in the bones. In the eyes the amount of ^{89}Sr retained at 12 weeks of age was the same in all groups. In brain tissue, as the level of IP increased, sp act. of ash increased at 2, 7, and 12 days postinjection. The most striking differences were noted in the ^{89}Sr content of excreta. When 0.1% IP was fed, the birds excreted 3.97 μCi of ^{89}Sr or 81.4% of the total dose administered. When IP was increased 5-fold, the total ^{89}Sr excretion dropped to 2.99 μCi. The least amount (53.5%) of ^{89}Sr excreted was by birds fed 2.0% IP. Thus as the dietary level of IP was increased, the amount of ^{89}Sr excreted decreased and consequently a higher amount was retained in the body. (BBB)

14974 SPECIFIC INHIBITION OF ANTIBODY PRODUCTION: STANDARDIZATION OF THE ANTIGEN-ELIMINATION TEST; IMMUNOLOGICAL PARALYSIS OF MICE PREVIOUSLY IMMUNIZED. Dresser, D. W. (National Inst. for Medical Research, London). Immunology, 9: 261-73 (1965).

X irradiation was used to enhance antigenic paralysis of mice in standardization of an antigen-elimination test. The test was calibrated by passive immunization experiments in which the amounts of antigen or antibody were altered in order to investigate the possibility of inducing immunological paralysis in mice with bovine γ-globulin (BGG). It was found necessary to start with an injection of 300 mg BGG and follow this by a course of twice-weekly injections of exponentially (X2) increasing amounts. X irradiation increased the ability of antigen to paralyze. Irradiation by itself led to an actual increase in titer to BGG, whereas when combined with 70 mg of BGG in paralyzing injections, there was a 64-fold suppression of BGG titer when the result of the treatment was compared with the response in nonirradiated, nonparalyzed controls. The injection of Freund's adjuvant made up with saline and no antigen, at the same time as irradiation, seemed to have only a marginal effect in irradiated mice. In paralysis experiments carried out in animals treated with x irradiation, in general, the effect of this nonspecific treatment was to lower the concentration of antigen necessary for paralysis induction, which could be the result of considerably lower amounts of antibody being produced. It was thought that x irradiation killed a proportion of cells, leaving the rest unscathed; this probably did not effectively lower the concentration of antigen necessary for paralysis induction, so that there must also have been a general impairment of cellular function after x irradiation. Results from experiments with irradiation indicated that it was intracellular antibody that made the mature or immune cell more difficult to paralyze than the immature or nonimmune cell. (BBB)

14975 THE UPTAKE AND LOCALIZATION OF PROTEINS, EVANS BLUE, AND CARBON BLACK IN THE NORMAL AND PATHOLOGICAL THYMUS OF THE GUINEA PIG. Blau, J. N.; Veall, N. (Guy's Hospital Medical School, London). Immunology, 12: 363-72 (Apr. 1967).

Radiobiologic studies were directed to the question: why does the normal thymus fail to form germinal centers as the spleen and lymph nodes do? Radioiodine-labeled homologous serum albumin and heterologous γ-globulin were found to reach the extravascular space of the guinea pig thymus in concentrations comparable with those in the spleen and in lymph nodes. The uptake of proteins in a locally x-irradiated (300 R) involuting thymus gland was doubled at 6, 12, 24, and 48 hr compared with nonirradiated controls. At seven days post-irradiation the concentration was greater than in the other lymphoid tissues examined, namely spleen, cervical and mesenteric lymph nodes, and was greater than in control glands by a factor of two to four. Localization of foreign material was studied with Evans Blue and carbon black that were found in macrophages of the capsule, cortex, and medulla, and in Hassall's corpuscles. The foreign material showed a marked increase in the parenchyma of glands during involution whether produced by x-irradiation, cortisone, or ACTH. (BBB)

14976 SOME ATTEMPTS TO INFLUENCE THE PERCUTANEOUS ABSORPTION RATE OF SODIUM (^{22}Na) AND MERCURIC (^{203}Hg) CHLORIDES IN THE GUINEA PIG: EFFECT OF SOAP, ALKYL ARYL SULFONATE, STRIPPING, AND PRETREATMENT WITH DISTILLED WATER AND MERCURIC CHLORIDE. Wahlberg, Jan. E. (Karolinska Sjukhuset, Stockholm). Acta Dermato-Venerol., 45: 335-43 (1965).

Penetration of ^{22}Na and ^{203}Hg (as chlorides) through guinea pig skin was studied. Radioisotope disappearance measurements were made with three types of vehicles: distilled water, 1% alkyl aryl sulfonate solution, and soap solution. The absorption rate, through stripped skin and through skin pretreated with distilled water and with different concentrations of $^{203}HgCl_2$ for various periods of time, was also investigated. The relative absorption of ^{22}Na in aqueous solution was about the same over the concentration range 0.005 to 0.398 M, whereas the absolute absorption gradually increased. With alkyl aryl sulfonate and soap as vehicles, and through stripped skin, absorption increased for the highest (0.239 M) of the four $^{203}HgCl_2$ concentrations studied. Absorption of ^{22}Na through stripped skin increased 40 to 50 times at a concentration of 0.000038 M and about 5 times at 0.239 M, as compared with normal skin. When the skin was pretreated with distilled water, the absorption of aqueous solutions of ^{22}Na and ^{203}Hg decreased. Pretreatment with $HgCl_2$ solutions did not affect the absorption of ^{203}Hg; on the other hand, the absorption of ^{22}Na through both stripped and unstripped skin was reduced. (BBB)

14977 A SIMPLIFIED METHOD FOR MEASURING THE VOLUME OF EXTRACELLULAR FLUID BY RADIOACTIVE SULFUR (^{35}S): OBSERVATIONS ON SHIFTS OF FLUID IN INDUCED HYPOTENSION. Albert, S. N.; Shibuya, J.; Custeau, P.; Albert, C. A.; Hirsch, E. F. (Washington Hospital Center, Washington, D. C.). S. Med. J., 60: 933-9 (Sept. 1967).

A radioisotope method was devised to measure shifts in fluid between the interstitial and intravascular space under sustained hypotension, and used in 18 mongrel dogs. Plasma and red cell volumes were measured simultaneously by a dual tracer method using ^{51}Cr-labeled red cells and ^{125}I-labeled albumin. Both tracers were administered, mixed in one syringe, through the jugular vein. This was immediately followed by the administration of a premeasured volume of standard containing a known quantity of

^{35}S-sulfate, (~1 μCi/Kg). The concentrations of ^{51}Cr and ^{125}I were analyzed simultaneously on whole blood samples in a modified scintillation counter, attached to a dual scaler analyzer. The ^{35}S, a weak β emitter, was measured in a separate detector system which consisted of an anthracene cell attached to a photomultiplier tube with a scaler. The protein-free plasma filtrate was introduced into the anthracene cell for radioanalysis of ^{35}S. The concentration of ^{35}S in the plasma filtrate, expressed in μCi/l, was obtained from the reference curve established by plotting known concentrations of ^{35}S vs count rate. Calculations were based on the extrapolated count rate obtained when the concentration of ^{35}S was stabilized and fell in a slow, steady, exponential manner. This relatively simple and rapid method for measuring blood and extracellular fluid volume utilizing three radioactive tracers was applied to the study of shifts between the interstitial and intravascular space under induced hypotension. (BBB)

14978 A CONSTANT FLOW APPARATUS FOR MEASURING RADIOACTIVE ION EFFLUXES FROM GUINEA PIG TENIA COLI. Brading, Alison F. (Oxford Univ.). J. Physiol. (London), 192: 15P-16P(Sept. 1967).

An apparatus was developed that avoids disadvantages of measuring ion effluxes as usually done, by transferring the radioactively loaded tissue through a series of tubes containing inactive solution. Transfer in the usual way involves changes in environment which may affect the spontaneous activity of the tenia; it is subject to timing errors; and radioactive fluid carried over with the tissue may obscure the results. Each tube must contain a volume of fluid sufficient to cover the tissue, and, for counting β emitters, this volume is often too large for direct incorporation into the scintillation fluid. These disadvantages prevent the determination of an efflux curve sufficiently accurate to justify compartmental analysis in any detail. In the constant flow apparatus designed to provide a constant environment for the tissue, samples are collected at intervals directly into the counting vials, thus avoiding transfer errors, and, for β emitters, a size small enough to be incorporated into the scintillation fluid is chosen. The apparatus is enclosed in a glass-jacketed constant-temperature bath. The tenia is mounted on a holder and is equilibrated with the radioactive solution in a separate bath. To wash out, the holder and tissue are dipped into a large bath of nonactive solution to remove adhering radioactive solution, plugged into the channel, and then the solution is run through the chamber at maximum rate until it is full and free from air bubbles. Repeated wash-outs of the same tissue gave similar results, and efflux curves calculated from experiments with this apparatus were sufficiently accurate to justify compartmental analysis. (BBB)

Ecology

Refer also to abstract 15290.

14979 (COO-1406-2) EFFECTS OF IRRADIATION ON THE BEHAVIOR OF SMALL MAMMALS UNDER FIELD CONDITIONS. Annual Progress Report. Orr, Howard D. (Saint Olaf Coll., Northfield, Minn.). Sept. 30, 1967. Contract AT(11-1)-1406. 14p. Dep. CFSTI.

Ten groups of mice were released into a two acre field enclosure during three summer seasons. Populations introduced tended to exhibit similar curves, always indicating decline. Populations introduced did not affect those already present. Studies were conducted for the purpose of answering basic questions preliminary to work on the effects of x radiation on home range behavior. Animals were injected subcutaneously with ^{182}Ta and a portable scintillation detector was used to survey movements of mice. The chief factors contributing to population decline were escape and predation. A group of 20 young mice was released to study the effects of age on behavior. It was found that the behavior of the young animals was not different from that of adults. Movements of individuals were determined by the average distance between successive captures, and graphs are presented to show home range patterns of animals in the field enclosure. Mice were trapped in four major habitats: grassy roadside ditches, alfalfa fields, corn fields, and soya bean fields. Results are given as per cent of capture (number of animals per trap set). In order to study the effects of x radiation on home range behavior, adults were allowed to develop a home range, were removed, exposed to a single dose of 100 or 800 R, and returned. It was found that irradiation decreased average distance between captures, area of home range, and change in center of activity. Effects of radiation on learning were studied by constructing a maze and exposing animals neonatally to x radiation. The tabulated results show that the irradiated mice required longer than controls to complete the maze. Prairie deer mice were analyzed for total body levels of the trace elements, Cu, Fe, Mn, Pb, and Zn. The results showed that individuals captured in different habitats differed in amounts of copper and lead but not in other elements. Three one-acre plots were established for long range studies on the population structure of chipmunks. A table is presented to show estimated density per acre, sex ratios, mean weight and range, and average distance between captures. (H.L.W.)

14980 CYCLING OF TRACE ELEMENTS IN THE ESTUARINE ENVIRONMENT. I. MOVEMENT AND DISTRIBUTION OF ^{65}Zn AND STABLE ZINC IN EXPERIMENTAL PONDS. Duke, Thomas W.; Willis, James N.; Price, Thomas J. (Bureau of Commercial Fisheries, Beaufort, N. C.). Chesapeake Sci., 7: 1-10(Mar. 1966).

The movement of ^{65}Zn in the water, biota (macrobiota), and sediment of two experimental ecosystems was studied to determine some factors that controlled this movement, and to determine if the distribution of ^{65}Zn was related to the distribution of stable Zn in the system. Of the two estuarine ponds studied, Pond I was essentially a closed system and Pond II was connected to an adjoining estuary. In Pond I, ^{65}Zn moved rapidly from the water to other components of the ecosystem so that after one day only 66% remained in the water. In Pond II, ~82% of ^{65}Zn was flushed out within one day by tidal exchange of water between the pond and the adjoining estuary; of the ^{65}Zn remaining, 36% was in bottom sediment, 59% in the water (one-third of the amount in the water was associated with suspended material), and 5% in the macrobiota. After 100 days, the bulk of ^{65}Zn and stable Zn was in the sediment of each pond. Analysis of specific activity (μμCi ^{65}Zn/μg Zn) in components of the ecosystem indicated that the exchange of Zn between sediment and water dominated the cycling of this element and controlled the distribution of ^{65}Zn in the ponds. (BBB)

Genetics and Cytogenetics

Refer also to abstracts 14942 and 15096.

14981 NUCLEAR-CYTOPLASMIC FACTORS AND SEXUAL DIFFERENTIATION OF ALLOMYCES: SELECTIVE INHIBITION BY ACRIDINES AND ACTINOMYCIN D. Turian, G. (Univ., Geneva); Viswanathan, M. A. Pathol. Microbiol., 29: 705-29 (1966). (In French).

After uv irradiation (2537 Å) or heating (37 to 40°C), the percentage of male compared to female gametangia differentiated on the gametophytic growth of Allomyces strains was increased. Maleness was also increased slightly in semi-synthetic media enriched in glycine (antagonism with casein hydrolysate) or folic acid, more so in media with acetate as C source, and markedly with thymine (optimally with thymidine). Azathymine, uracil, and azauracil were moderately masculinizing on Allomyces, in that decreasing order. Maleness was also promoted slightly by traces of the toxic actidione, but much more effectively by growing Allomyces strains in the presence of the acridines proflavine and acridine orange, that tend selectively to inhibit female gametangial differentiation. Under the effect of uv irradiation the percentage of male A. arbusculus increased from 48.5% in controls to 53.6% after 20-min irradiation. After longer periods of uv irradiation a lethal effect began to predominate over the masculinizing one. Permanently changed colonies (smaller, masculinized) were obtained by plating meiospores on media containing acridine, actidione, and actinomycin or after uv irradiation. A conceptual scheme is proposed to explain phenotypic and genotypic data concerned with sexual differentiation in Allomyces species. A φ particle responsible for female differentiation is postulated to be freed from its chromosomal location, according to a polarity gradient genetically controlled (gen pol), into the presumptive female cytoplasm at the inductive process of gametangial differentiation. (BBB)

14982 CHROMOSOME REARRANGEMENTS INDUCED IN THE MOUSE BY EMBRYONIC X IRRADIATION. I. PRONUCLEAR STAGE. Leonard, A.; Deknudt, Gh. (Centre for Studies on Nuclear Energy, Mol, Belg.). Mutat. Res., 4: 689-97(Sept.-Oct. 1967).

BALB/c females with vaginal plugs (day 0.5 after copulation) received x irradiation to the whole body; 100 R killed about 45% of the embryos. Thirty-eight males and 24 females irradiated at the pronuclear stage were mated with control mice from the same strain, and the testes of their sons were examined for the presence of chromosome rearrangements. Three males irradiated at day 0.5 were found to be heterozygous for different reciprocal translocations. The overall frequency of induction of translocations per genome was 2.53%. Mitotic preparations made from bone-marrow of the three translocated animals showed no recognizably abnormal chromosomes. (auth)

14983 THE CHROMOSOME BREAKING EFFECT OF THE IRRADIATED ENDOSPERM IN WATER-SOAKED SEEDS OF DURUM WHEAT. Avanzi, Silvana; Corsi, Gabriella; D'Amato,

F.; Floris, C.; Meletti, P. (Univ., Pisa, Italy). Mutat. Res., 4: 704-7(Sept.-Oct. 1967).

Seeds of Triticum durum (wheat) were soaked in deionized water for 24 hr at 20°C in the dark and then x-irradiated at doses of 500, 1000, 2000, and 4000 R. Embryos were excised from irradiated and nonirradiated seed and the following embryo transplants were made: nonirradiated homotransplants (controls) and nonirradiated embryos onto irradiated endosperm. Chromosome breakage at anaphase and all anaphases present in root tip cells were scored. It was seen that the mitotic activity rose progressively with time in both intact seeds and transplants. When nonirradiated embryos were transplanted onto irradiated endosperm there was a clear increase, over the nonirradiated homotransplant values, of both the frequency of aberrant anaphases and the number of chromatid breaks per anaphase. The mechanisms responsible for the breaking of chromosomes in the irradiated endosperm are briefly discussed. (B.H.S.)

14984 SOME POSTIRRADIATION FACTORS AFFECTING THE INDUCTION OF CHROMOSOME ABERRATIONS BY IONIZING RADIATION: CONTROL OF REJOINING AT SITES. Kumar, Sushil; Natarajan, A. T. (Indian Agricultural Research Inst., New Delhi). Mutat. Res., 4: 601-4(Sept.-Oct. 1967).

Postirradiation environments obtained by confounding different levels of temperature with oxygen or anoxia have been used to study the control of rejoining, determining expression of chromosome exchange forming sites in the root meristem cells of germinating barley seeds. The best environment for rejoining leading to exchange formation is anoxia at 30°. The restitutional rejoining is highly promoted by oxygen at 30°. The distributions of exchanges between cells are narrow and non-Poisson in environments determining low level of expression of sites and dispersed and Poisson in environments determining high level of expression of sites. These properties suggest the existence of a large number of exchange forming sites in nuclei, whose exchange forming function is controlled by the metabolic state of the cells. Active metabolic states of the cells permit expression of only a limited number of the possible exchange sites, abolishing the function of the rest. (auth)

14985 THE EFFECT OF γ IRRADIATION ON A POLYGENICALLY INHERITED CHARACTER IN NICOTIANA TABACUM L. IN RELATION TO SELECTION AFTER TREATMENT OF AGED SEEDS. Ando, Akihiko; Vencovsky, Roland (Sao Paulo Univ., Brazil). Mutat. Res., 4: 605-14(Sept.-Oct. 1967).

The gamma radiosensitivity of 2-, 3- and 5-year old seeds of Nicotiana tabacum (var. Amarelinho Tietê) was studied. In the R_1, it was confirmed that germination rate, survival rate and seedling height decreased with age of seeds and with radiation dose, and that the LD_{50} was also dependent on the age of seeds. Polygenic inheritance of corolla length in the R_2 and R_3 raised from the irradiated aged seeds was studied. The results showed that the variabilities in the R_2 and R_3 differed depending on age and radiation dose. Older seeds had higher variances due to irradiation and higher estimated heritabilities than younger seeds in the R_2 as well as R_3. The realized heritabilities did not show such clear-cut results. Among the realized heritabilities there was considerable interaction between age of seeds and radiation dosage, with the highest value being for low dose (15,800 R) of the oldest seeds. These results suggested that selection for polygenic characters following irradiation of older seeds might be more effective than using younger seeds, not only in the R_2 but also in the R_3 and perhaps also in the later generations. (auth)

14986 INDUCED CROSSING-OVER IN THE MALES OF DROSOPHILA ANANASSAE: EXCHANGES MAINLY IN SPERMATOCYTES OF ADULTS. Kale, P. G. (Banaras Hindu Univ., India). Mutat. Res., 4: 631-9(Sept.-Oct. 1967).

Crossing-over in males of D. ananassae was studied by treating young and 48 hr-old adults with 1000 R and 2000 R of X rays. Among the 76 irradiated males only three showed exchanges in their gonial cells, while the others produced crossovers in the period of partial sterility. The individual variation in crossover production of these males can be fitted to a Poisson distribution and the complementary recombinants from the individual males showed no significant departures for equality. These crossovers therefore appeared to have originated in treated spermatocytes. Continued appearance of only one complementary recombinant class in two males gave evidence in favor of cambial-like divisions of the primary spermatogonia. A proportional increase of recombination frequency with radiation dose, after exposure of adults, suggested a one-hit nature of induced crossing-over. (auth)

14987 THE EFFECTS OF NITROGEN AND OXYGEN TREATMENTS ON THE FREQUENCIES OF X-RAY-INDUCED DOMINANT LETHALS AND ON THE PHYSIOLOGY OF THE SPERM IN DROSOPHILA MELANOGASTER. Sankaranarayanan, K. (Univ. of Leiden, Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res., 4: 641-61(Sept.-Oct. 1967).

The induction of dominant lethals in Drosophila melanogaster males with a ring-X chromosome was studied following irradiation with 4000 R under anoxia with nitrogen and oxygen post-treatments. The postradiation treatment with these gases varied from 25 min to 120 min. The frequencies of induced dominant lethals were found to be in the range of 67% to 73% in the different experiments with no significant differences resulting from the contrasting post-treatments. These frequencies increased linearly in the successive egg-collecting periods, the trend being independent of the different post-treatments. Following prolonged nitrogen treatments, a sharp increase in the proportion of unhatched eggs was noticed. Examination of the ventral receptacles and spermathecae of females inseminated by nitrogen-treated males revealed that with nitrogen treatment there occurred a drastic reduction in the number of spermatozoa stored, the magnitude of reduction being dependent on the length of nitrogen treatment; and there was a decrease with time in the number of spermatozoa remaining in the storage organs, with the effect being pronounced with 96 and 120 hr of storage following insemination. These findings are discussed in relation to physiological damage to the treated sperm and sperm exhaustion. (auth)

14988 X-RAY-INDUCED CHROMOSOMAL ABERRATIONS IN VICIA FABA: CHANGES IN RESPONSE DURING THE CELL CYCLE. Scott, D.; Evans, H. J. (Medical Research Council, Harwell, Eng. Univ. of Aberdeen, Eng.). Mutat. Res., 4: 579-99(Sept.-Oct. 1967).

Primary roots of Vicia faba were pulse labeled with tritiated thymidine followed immediately by 0, 50, 100 or 150 rads of x rays and fixed from 0 to 48 h posttreatment. Autoradiographs of root meristem cells were prepared and mitotic cells scored for the presence or absence of labelling and chromosomal aberrations (including achromatic lesions or gaps). As the x ray dose was increased, the duration of the postsynthetic (G_2) phase increased. After 50 rads DNA synthesising (S) cells were partially synchronized, while the 100 and 150 rad doses caused a protraction of the S phase. There was a pronounced double peak of chromatid aberrations in the highly sensitive G_2 phase after 100 or 150 rads, the yield falling throughout S and a low frequency of chromosome-type aberration was induced in G_1 cells. A postive correlation was established between the degree of incompleteness of chromatid interchanges and the radiation dose for cells in G_2 and at the time of peak frequency of aberrations, but not for cells irradiated while in the S phase. The ratio of true chromatid breaks to incomplete isochromatid breaks differed from that predicted by the exchange hypothesis of Revell [Proc. Roy. Soc. (London), Ser. B 150: 563-89 (1959)] and differed significantly from one mitotic stage to another. The partitioning of the mitotic cycle into its various phases enabled the relation between aberration yield and dose to be determined for all aberration types induced in the different phases of interphase. Dose response kinetic for a given aberration type were found to be strongly influenced by stage in cell development at the time of irradiation. It was suggested that these kinetic differences between stages were due to differences in the time available for repair and to changes in the organization of chromatid structure during replication. The data are interpreted as being at variance with the classical breakage-rejoining hypothesis of aberration formation and, to some extent, with REVELL'S exchange hypothesis. It is concluded however that all aberrations (excluding gaps) are a consequence of exchange following a process of mis-repair of primary lesions that are not chromatid breaks. (auth)

14989 THE MITOTIC ACTIVITY AND DEGENERATION OF EPITHELIAL DUODENAL CELLS OF MICE IRRADIATED WITH 240 MeV PROTONS AT VARIOUS DOSES. Mastryukova, V. M.; Strzhizhovskii, A. D. (Inst. of Medical and Biological Problems, Moscow). Radiobiologiya, 7: 537-40(1967). (In Russian).

Mice weighing 18-20 g were irradiated with 240 MeV protons at doses of 200 and 700 R (dose rate about 0.3 R/sec) and decapitated after 6, 24, 72, and 168 hours. Fifty-six sections of epithelial cells were prepared and studied. In the first mitotic cycle after irradiation the number of chromosome aberrations increased exponentially with increasing dose. The mean effective dose was 500 R. Aberrant cells of the crypt epithelium lost their capacity for unlimited multiplication. The mean number of divisions of an aberrant cell up to reproductive death was 8.9. A relative biological effect of about 1.0 was found in this study of the genetic effect of 240 MeV protons. (JPRS)

14990 THE EFFECTS OF X RAYS ON THE CHROMOSOMES OF NITELLA FLAGELLIFORMIS BR. Sarma, Y. S. R. K.; Khan, M. (Banaras Hindu Univ., India). Nucleus (Calcutta), 10: 90-3(June 1967).

Nitella flagelliformis, with a chromosome number of n = 9, was used to study the effects of x rays on chromosomes because of the appreciable size of the chromosomes of this species and general lack of chromosome stickiness. Effects of x-ray doses of 100 to 500 R were examined in detail with respect to metaphase and anaphase stages. The control material showed nine chromosomes, normal karyological features, and none of the effects described below. The x-ray-induced fragments at metaphase appeared as short rods, while those at anaphase varied in shape from short rods to tiny spheres. The fragments were near their respective chromosomes or lying as separate entities scattered in the nucleus and ranged from one to three at metaphase and one to several at anaphase, increasing in general with increase in dose. One or rarely two fragments per metaphase were detected up to 200 R, but with increased doses, two to three fragments per metaphase were frequent. The chromosome fragments, both large and small, were distributed within daughter nuclei and only rarely remained at the equator. Occasionally, formation of micronuclei was observed, probably from a few of the chromosome fragments. A comparison of relative size of the different fragment indicated both chromosome and chromatid breaks. Ring chromosomes, though infrequent, were found both at metaphase and anaphase. Anaphase bridges were more frequent. (BBB)

14991 HYBRIDIZATION STUDIES WITH DATURA X-RAY MUTANTS. Steinegger, E.; Spillman, P. (Univ., Bern). Pharm. Acta Helv., 42: 183-9(Mar. 1967). (In German).

The fertility characteristics of x-ray mutants of Datura stramonium var. godronii were studied. After crossing the mutants with the initial material the F_1 generation showed characteristics that appeared to be recessive. The number of leaves, height, surface area, and the alkaloid concentrations of the hybrids were far greater than the average values in the parents. The water content was unchanged, but the capsule and seed numbers increased markedly. There was a very marked positive heterosis in the characteristics noted. In the F_2 generation the crossings between the starting variety and the single mutants appeared in a ratio of 1:3. They followed the dominant genetic pattern, where the mutation characteristics seemed recessive. In the crossings of the mutants with one another the characteristics appeared in a ratio of ~1:1:2, corresponding to a separate cleavage of the two characteristics in a ratio of 1:3. The observation that there were no plants that showed the characteristics of both parent mutants at the same time indicated that the mutated genes were localized in the same chromosome. (BBB)

14992 GAMMA RADIATION AND INTERSPECIFIC HYBRIDIZATION IN JUTE (CORCHORUS CAPSULARIS L. AND C. OLITORIUS L.). Mia, M. M.; Shaikh, A. Q. (Atomic Energy Center, Dacca, Pakistan). Euphytica, 16: 61-8(1967).

Dry seeds of C. capsularis var. D-154 and C. olitorius var. chinsura green (C.G.) were treated with 70, 80, 90, and 100 kR doses of γ rays from ^{60}Co. The irradiated seeds were sown in the field, and 300 crosses between the two species were made in different combinations of radiation doses. Abnormal plants of the first generation showing radioinduced bilobed and crinkled characters in their leaves were chosen as male parents; in all, 120 fruits developed into maturity. All the seeds failed to germinate except those from the crosses ♀ C.G. (0 kR) × ♂ D-154 (80 kR) and ♀ D-154 (0 kR) × ♂ C.G. (70 kR). F_1 plants from the cross ♀ C.G. (0 kR) × ♂ D-154 (80 kR) inherited the bilobed character of the male parent whereas the plants from the other cross failed to show any sign of inheritance of the male parent. This indicated that the plants from the cross ♀ C.G. (0 kR) × ♂ D-154 (80 kR) were hybrids. These hybrids attained a greater height than the controls and were highly fertile. Intermediate base diameters of the hybrids indicated the absence of dominance of this character. Increased plant height in the F_1 generation might be due to hybrid vigor or other unknown factors. (BBB)

14993 RADIATION-INDUCED MUTANT HAVING LESS TILLERING IN RICE. Futsuhara, Yuzo; Yamaguchi, Hikoyuki (Tokyo Univ.). Ikushugaku Zasshi, 13: 183-5(Sept. 1963). (In Japanese).

The development of a γ radiation-induced rice mutant is reported. The mutant showed the characteristics of increased seed number per stem and short but strong stems. However, the harvest rate was relatively low. Genetic studies on the characteristics of lower tillering and harvest rate are discussed. In the experiments described, dry rice seeds of the Fujiminori variety were irradiated with ^{60}Co γ rays at a dose of 30 kR. Among 275 plants, one mutant was observed to have a less tillering. The 13 R_2 individuals of the mutant yielded 3 no-tillering, 1 one-tillering, and 9 normal-tillering plants. The R_2 plants showed early growth, increased seeds per stem, short stem, and low harvest rate characteristics. The less tillering R_2 mutant was propagated to produce R_3 plants. In the R_3 generation, more less-tillering t-type mutants were isolated. The isolation rate calculated according to Fisher's sib method was 0.3165 which suggests significantly higher recessive genes in the mutant. To study whether the low yield in the mutant was due to a male or female factor, or due to their incompatibility, the t-type mutant was mated with the normal type under various experimental conditions. The results showed that there was no grain yield with the t-type mutant as female parent but a normal yield in the t-type male parent group. Therefore, the low yield of the t-type mutant was considered to be due to derangement in female mutant. (BBB)

14994 THE EFFECT OF PRETREATMENT WITH MALEIC HYDRAZIDE OF THE MUTATION RATE INDUCED BY GAMMA RADIATION IN DROSOPHILA MELANOGASTER. Nasrat, G. E. (Univ. of Cairo). Nippon Idengaku Zasshi, 42: 39-42(Feb. 1967).

Maleic hydrazide breaks plant chromosomes and has pronounced effects on cell division in roots. Since maleic hydrazide has only a weak mutagenic effect in Drosophila, it was tested for synergistic action with ionizing irradiation. A 1500-rad dose of ^{60}Co was used in tests for sex-linked recessive lethals on the progeny of treated wild-type Oregon-K (Or-K) males. The chemically treated flies were divided into 2 groups, and 1 was irradiated. After chemical treatment alone the rate of sex-linked recessive lethals recorded in 3 successive broods increased in the first, dropped in the second, and reached the limits of the spontaneous mutation rate in the third. After irradiation alone the rate of sex-linked recessive lethals was high also in the first brood, but increased significantly in the second brood, and the third brood, although it fell below that of the first brood, it was still significantly higher than the spontaneous mutation rate. After combined treatment the mutation rate in each of the 3 successive broods equaled the additive value for the 2 separate treatments. In the second brood, after combined treatment the value was higher than the additive value, but not significantly. (BBB)

14995 COMPARATIVE PATHOGENICITY OF VESICULAR STOMATITIS VIRUS AND ITS PLAQUE TYPE MUTANTS. Shechmeister, I. L.; Streckfuss, J.; St. John, R. (Southern Illinois Univ., Carbondale). Arch. Gesam. Virusforsch., 21: 127-32(Sept. 1967).

The induction of mutants of vesicular stomatitis virus (VSV) by uv irradiation and evaluation of their pathogenicity are reported. Mutants obtained after exposure of VSV to uv light could be grouped by plaque size on primary chick fibroblast monolayers. The Ogden strain of the New Jersey serotype of VSV (W^+) forms a large plaque on chick embryo fibroblast cells and also plaques with similar efficiency of plating (EOP) on HeLa, L, and PK cells. The EOP on HeLa cells for the small plaque type, uv-induced mutants varied from 0.01 to 0.10. The intermediate plaque size mutants showed a similar EOP on HeLa monolayers as did the wild-type virus. Intracerebral infection in mice of 4.4 to 7.4 plaque-forming units (PFU) of W^+ or the intermediate plaque size was lethal; however, mice did not succumb to infection of about 1×10^8 PFU of the small plaque type mutants. Growth curves of W^+ and the small plaque type mutant in vivo are described. (BBB)

14996 PURIFICATION OF NONSHATTERING POD CHARACTER IN JRO-632 VARIANTS ARISING FROM X-RAY IRRADIATION. Agr. Res. (New Delhi), 2: 195(1962).

Seeds from some selected progenies of JRO-632 jute (C. olitorius) after 20,000-, 40,000-, and 70,000-R x-ray treatment showing normal morphological features, and back-crossed seeds of "Tobacco leaf" (50,000-R) and "Crumpled leaf" (90,000-R) variants of nonshattering pods were sown for segregation study in the X_5 generation. (BBB)

14997 SELECTION FOR DROUGHT RESISTANCE AND EARLINESS FROM X-RAY-IRRADIATED PROGENIES OF CORCHORUS CAPSULARIS. Agr. Res. (New Delhi), 2: 195(1962).

Some progenies of the JRC-919 jute variety after 40,000- and 70,000-R x-ray treatments were found to be drought resistant and to mature 23 days earlier than in the control. Seeds from selected progenies of the JRC-919 and JRC-212 jute varieties, characterized by resistance to drought and resulting from x-ray treatments of 30,000 to 100,000 R, were propagated for further studies. (BBB)

14998 YIELD TRIAL OF NONBRANCHING EARLY-FLOWERING VARIANTS OF JRC-919 ARISING FROM X-RAY IRRADIATION. Agr. Res. (New Delhi), 2: 194-5(1962).

Pigmentation variants (Grade 4) in JRC-919 jute (Corchorus capsularis) nonbranching type, belonging to the progenies of 30,000- and 40,000-R x-radiation treatments, in general, yielded 7% more fiber than the control jute (originally Grade 1 and branching). However, in the nonbranching, early-maturing types belonging to the 80,000- and 90,000-R treatment groups (Grade 1 and Grade 4, respectively, and earlier by 30 to 35 days) the yield

of fiber was the same as in the control. Seeds from selected progenies were sown in replicated lattice design for study in the X_5 generation. (BBB)

Health Physics and Safety

Refer also to abstracts 14588, 14591, 14846, 14847, 14851, 15084, 15134, and 16356.

14999 (AECL–2699) STUDIES AND TECHNIQUES IN TRITIUM HEALTH PHYSICS AT CRNL. Osborne, R. V. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1967. 19p. (CONF-670218–2). Dep. CFSTI. CAN.

From Symposium on Instrumentation, Experience, and Problems in Health Physics Tritium Control, Albuquerque, N. Mex.

Ionization chambers and plastic scintillation detectors are used to measure tritiated water (HTO) vapor in air down to 0.5 μCi m^{-3}. Their responses to gamma background are reduced 98% by subtracting the ionization current from a concentric sealed ionization chamber and by scintillation pulse height analysis. The penetration of HTO through human skin was studied experimentally by exposing volunteers to HTO vapor. The average intake through the total skin area was 10 μCi min^{-1} from a concentration in air of 1 μCi liter^{-1}. This intake rate was reduced at least 10 times when a 0.004″ polyvinyl chloride (PVC) suit was worn and 1000 times when a suit made up of a double layer of PVC enclosing a film of water was worn. The permeation of HTO in several hours through the latter was lower than that through any of the other polymeric films, suitable for protective clothing, that were measured in the laboratory. Respirators with charcoal filters were shown to hold up passage of HTO vapor; the respiratory intake was reduced by at least 10 times for a total inhalation of 1.0 m^3 of air. Air-supplied respirators were better; a 10^4 times reduction was obtained experimentally. An automatic urinalyzer allows workers to measure their own body burdens of tritium in two minutes. The instrument uses liquid scintillator to detect tritium in urine. As little as 1 μCi liter^{-1} may be measured. (auth)

15000 (NLCO–1007) ESTIMATION OF THORIUM IN THE BODY. Boback, M. W.; Heatherton, R. C. (National Lead Co. of Ohio, Cincinnati). Sept. 22, 1967. Contract AT(30-1)-1156. 10p. (CONF-671048–2). Dep. CFSTI.

From 13th Meeting on Bioassay and Analytical Chemistry, Berkeley, Calif.

Three methods for the estimation of exposure to airborne thorium are discussed: in vivo counting, the neutron-activation determination of thorium in urine, and breath thoron measurements. The limited data obtained in tests to date indicate that the present limits for inhalation exposure to thorium are adequate. (auth)

15001 (RA–30) ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET IN THE NETHERLANDS DURING 1966. Mattern, F. C. M.; Drost, R.; Strackee, L. (Rijks Instituut voor de Volksgezondheid, Bilthoven (Netherlands). Laboratorium voor Stralingsonderzoek). Sept. 1967. 30p. Dep.

Tables are presented to show the content of ^{137}Cs and ^{90}Sr in cheese, eggs, flour, fruit, meat, milk, potatoes, vegetables, and water in 1966. The yearly mean of the daily dietary intake of ^{137}Cs is estimated as 92 pCi/day, and of ^{90}Sr as 20 pCi/day. Sampling procedures are described, and the computation of the estimated values from the national food balance sheet is given in some detail. (H.L.W.)

15002 (SC–M–67–2959) ABSTRACTS FROM PAPERS PRESENTED AT THE JOINT ANNUAL MEETING OF THE ROCKY MOUNTAIN SECTION OF THE AMERICAN INDUSTRIAL HYGIENE ASSOCIATION AND THE RIO GRANDE CHAPTER OF THE HEALTH PHYSICS SOCIETY HELD AT SANDIA LABORATORY, ALBUQUERQUE, NEW MEXICO, SEPTEMBER 29 AND 30, 1967. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. 12p. (CONF-670937). Dep. CFSTI.

Abstracts of 18 papers are presented. Topics included are exposures to lead fumes during Missile Silo disposal; the respirator program at Sandia; trichlorethylene exposure; pulmonary radiotoxicology; acute effects of external irradiation in large animals; toxicity of inhaled ^{91}Y in the dog; hazards associated with uranium mining; and other aspects of industrial hygiene and radiobiology. (H.L.W.)

15003 (AD–662586) SHIELDING IN NUCLEAR ENGINEERING. COLLECTION OF ARTICLES (SELECTED ARTICLES). Translated from Zashch. Pokrytiya At. Tekh., Sb. Statei, 5–10; 93–7; 126–36; 144–7; 260–70(1963). 51p. (FTD-HT–66–691; TT–7000445–449). CFSTI.

Five articles are included with the following titles: The role of Protective Shielding in Radiation Safety Systems, Use of Sheets with an Adhesive Layer as Protective Coating Against Radioactive Contamination, Investigation of Organic Coating Materials for Protective Coating from Radioactive Contaminations, the Application of Epoxy Coatings for Protection of Metallic and Concrete Surfaces, and Meters and Dosimeters for Study of Protection and the Protective Properties of Materials. (D.L.C.)

15004 ON SOME TECHNICAL AND DOSIMETRY PROBLEMS OF IRRADIATING ANIMALS. Koczkas, Gy.; Dosay, K. (Frederic Joliot-Curie National Research Inst., Budapest). Acta Biochim. Biophys. (Budapest), 1: 305–13(1966).

Some principles and practical considerations were given to aid investigators to increase accuracy in dosimetry in animal studies and to ensure the reproducibility of irradiation. When irradiating small and medium-size mammals, if a low energy radiation source was used, uniformity of exposure was increased by bilateral exposure. Bilateral exposure could be performed by the successive irradiation of both sides, half of the dose being delivered to one side of the animal, the other half to its other side. Special boxes for the exposure of mice, rats, and guinea pigs were illustrated. About 15 mice could be placed in a cylindrical container designed for the exposure of mice that was described. Since the periphery of the container was farther from the x-ray tube focus than its center, to eliminate inaccuracies due to varying distances from the focus (a common source of error), the bottom of the container had a spherical surface. For irradiation of homogenates and bacterial cultures, a high dose was sometimes necessary. Practically, this meant that the dose required had to be delivered within as short a time period as possible. For this, the irradiated object was placed close to the focus of the tube. Irradiation units to be used with the different x-ray equipment were shown. Since the thickness of the irradiated objects varied, adequate supports were used to ensure identical distances between focus and irradiated surfaces. Glass containers should not be used for irradiating micro-organisms since the higher atomic number of the glass could result in complex radiation patterns. Containers made of polyethylene were preferred. Necessity of continuous dose measurements during exposure and equipment for this were also discussed. (BBB)

15005 HIGH-ENERGY PROTON DEPTH-DOSE PATTERNS. Tanner, Raymond L.; Baily, Norman A.; Hilbert, Jerald W. (Hughes Research Labs., Malibu, Calif. Univ. of California, Los Angeles). Radiat. Res., 32: 861–74(1967).

The deposition of energy by monoenergetic unidirectional proton beams incident on polystyrene was investigated. Centerline depth-dose curves were established for protons having energies of 730 MeV, 630 MeV, 590 MeV, 300 MeV, 138 MeV, 45.8 MeV, and 21.4 MeV, incident normally on a large polystyrene phantom. The experimental data were adjusted for differences in the relative stopping power of tissue to polystyrene so that the depth-dose curves presented are in term of relative absorbed dose as a function of depth in tissue. The importance of the contribution to the absorbed dose by secondary particles produced by high-energy protons is well demonstrated by the rapid dose buildup which was observed. (auth)

15006 CONTRIBUTION OF INDIVIDUAL FOODS TO THE INCORPORATION OF ^{90}Sr AND ^{137}Cs. Ritter, R. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch.-Forsch., 129: 325–32(1966). (In German).

Animal average individual food intakes for numerous foodstuffs are listed and their contributions to the intake of ^{90}Sr and ^{137}Cs for the period 1960 to 1964 in Germany are itemized. Milk, potatoes, apples, and pork were the most important dietary sources of these radioisotopes. Concentration variations of ^{90}Sr in various types of food grains and average individual intakes are charted. The ash contents of various wheats and ryes are compared with the ^{90}Sr decontamination factors of flour manufacture. Variations in the ^{90}Sr and ^{137}Cs concentrations of spinach, milk, lettuce, apples, tomatoes, and potatoes are compared for the interval 1961 to 1964. The number of samples tested for their radioisotope concentrations could be restricted, but at least 30 to 50 measurements should be taken annually to obtain the basis needed for accurate estimation of the ^{90}Sr and ^{137}Cs concentrations in foodstuffs in Germany. (BBB)

15007 RADIATION THERAPY FOR SKIN CANCER. Martyn, Doris (Princess Margaret Hospital, Toronto). Can. Nurse, 63: 48–50(Feb. 1967).

Radiation protection of patient and radiotherapist, and reactions to irradiation in skin, as well as their prevention and treatment, are discussed. Since small doses received over a long period of time by personnel working in therapy departments were hazardous, certain precautions should be taken to minimize exposure. The

walls of the treatment room should be of thick concrete and the observation windows contain lead so that no stray radiation could filter to the outside. The technician was not allowed to be in the room while treatment was being carried out, but observed the patient through the specially protected window. To make sure that nurses and technicians did not receive irradiation beyond the maximum permissible level, dosimeter badges were worn and blood counts taken periodically. Most skin cancers were treated with superficial x rays at 100 KV. A thin sheet of lead (0.5 mm thick), which could be cut with scissors, was used to prevent irradiation of normal skin. Larger tumors were treated at a moderate voltage and the shielding had to be thicker to prevent irradiation of the surrounding normal tissues. Treatment around the eyelids required special lead shields to be placed inside the lids to protect the underlying eye. The shields were made of lead with the concave conjunctival surface coated with a thin layer of plastic. Within a day or two of being irradiated, the treated skin showed a faint erythema which increased over several days. This reached maximum intensity after about 10 days, and a moist desquamation of the skin often occurred at this time. During this period, trauma to the treated area should be avoided and the affected skin kept dry. If discomfort occurred, lanolin should be applied sparingly two or three times a day. If the reaction was unduly severe, as sometimes occurred in persons with fair or sensitive skin, 1% gentian violet solution applied several times a day would produce a scab and allow the underlying tissues to heal. Following moist desquamation, crusts appeared; these were best left to separate on their own. Separation usually occurred between the third and fourth weeks and a new pinkish skin was seen. The patient should be protected from sunlight, wind, and frost, since these could cause severe local reactions, manifested by redness, soreness, and weeping of the treated area, with delayed healing. Infection, too, must be avoided or increased scarring would result with impaired cosmetic result; the patient was advised against rubbing the area. If there was hair in the irradiated area, permanent epilation would usually result. (BBB)

15008 COMPOSITION OF MILK AFTER REMOVAL OF ^{90}Sr. Nutr. Rev., 25: 244-6(Aug. 1967).

The effect of resin treatment to remove ^{90}Sr on nutrients in milk was evaluated. The processing consisted of acidification with citric acid to pH 5.4, application to a cation exchange (Amberlite IR-210) resin column, and neutralization with KOH. The resin was preloaded with Ca, Mg, K, and Na to prevent the loss of these electrolytes from the milk. The flavor quality of processed milk was judged to be nearly as high as that of control milk. The milks also did not differ significantly in percentage of total solids, butterfat, or protein, although total ash was 14% higher in the processed milk, probably due to mineral loading of the resin. Carotene, vitamin A, riboflavin, pantothenic acid, folic acid, and vitamin B_{12} were not removed by processing. However, thiamine, niacin, and vitamin B_6 concentrations were found to be reduced by 50, 27, and 15%, respectively, in resin-treated milk. Approximately 30% of the Cu was removed by processing; this would be of little consequence to an adult's diet, but could be critical in the nutrition of infants. The percentage distribution of long chain fatty acids was the same in both milks. Feeding studies in rats and pigs showed that the alteration of nutrient concentrations had no untoward effects on growth or general well-being of the animals. However, the quantitative chances reported would have to be taken into consideration if diets were ever to be formulated using this milk product. (BBB)

15009 RADIATION HYGIENE AND PRACTICE IN DENTISTRY. II. J. Amer. Dent. Ass., 75: 1197-8(Nov. 1967).

Recommendations are made by the American Dental Association for radiation protection for the dentist, his employees, and his patients. Safeguards for protecting office personnel during dental radiography include proper shielding, use of radiation barriers and monitoring services when necessary, and proper operating procedures. Minimization of radiation exposure to the patient and office personnel will result from the use of modern radiographic equipment. Factors that must be considered in shielding include the classification of the person to be protected, work load of the office, distance from the x-ray machine to the person involved, voltage values at which the machine is used, materials and dimensions of the existing walls or barriers, and position of the machine and operator. To evaluate these conditions and make the necessary measurements, a survey of the dental office should be conducted by a health physicist. The use of film badges will help determine if a barrier is needed for the operator, and film badge service should be considered after a proper radiation survey of the office. The operator or assistant should never hold a film in place for a patient. Use of intraoral fluoroscopic mirrors is considered to be dangerous. (BBB)

15010 THE UNBORN PLAINTIFF. Gordon, David A. J. Forensic Med., 13: 23-37(Jan.-Mar. 1966).

Some deleterious effects of ionizing radiation on the fetus are examined in terms of the legal aspects of such injury. There is no doubt that irradiation has a detrimental effect on the fetus, and, depending upon the dosage, the result may be intrauterine death, maldevelopment or malformation, rendering of the conceptus sterile, or the causing of mutational changes, which may be transmissible to the descendants of the irradiated fetus. The possibility of negligent irradiation affecting the germ cells and thus producing hereditary congenital malformations introduces almost perpetual liability. However, the courts, when faced with this question, may limit the liability by compensating the original plaintiff for his inability to procreate normal children and thus leave the election whether or not to have children to the plaintiff without the possibility of involving once more the originally negligent defendant. As little as 15- or 20-R irradiation of the fetus may be sufficient to cause damage. There is some dispute as to whether or not the incidence of leukemia increases after fetal irradiation in diagnostic dosages. Further studies are necessary, but it seems clear that the pregnant uterus ought to be exposed to x rays no matter how small the dosage. This will raise problems where the mother requires therapeutic treatment in the fetal area, and in these circumstances it may be better to terminate the pregnancy. Two American legal decisions have dealt with the question of prenatal injuries as a result of irradiation and in both relief was denied as a matter of law. In Smith vs Luckhardt a physician negligently diagnosed a pregnancy as a uterine tumor and administered 6 half-hour x-ray treatments over a period of 3 months. The feeble-minded, crippled child lived to the age of 13 years but died subsequent to the commencement of the suit, which also failed, against a physician, who without the use of any of several tests available and solely after a manual examination, also treated a pregnancy as a tumor. (BBB)

15011 INVESTIGATIONS ON THE RADIOACTIVITY OF HONEY. Barabas, B.; Lupsan, V. (Disciplina de Chimie Fisica, Tirgu Mures, Roumania). Igiena (Bucharest), 16: .79-83(Feb. 1967). (In Rumanian).

Studies were conducted to determine the levels of natural and artificial radioactivity in honey collected in various localities in Roumania at various times of the year. Natural radioactivity would be expected to originate from ^{40}K, ^{14}C, and ^{226}Ra, and artificial radioactivity from the fallout nuclides ^{90}Sr and ^{137}Cs. Total activity, β and γ activity, and ^{90}Sr levels were estimated in 1.5-Kg samples of honey ashed at 600°C. For samples collected in 1964 in the following localities: Band (May to June), Toplita (July to Aug.), Caracal (May to June), Brosteni (July to Aug.), Tulghes (July to Aug.), and Barasau (July to Aug.), the aritficial and total radioactivities were 109.8, 110.8; 78.0, 81.1; 23.4, 24.3; 490.8, 490.0; 446.2, 462.9; and 300.8, 304.8 pCi/Kg fresh weight. The ^{90}Sr contents of the same samples, as pCi/Kg fresh weight and pCi/g ash, respectively, for samples from these six localities were: 10.8, 27.0, 9.0, 16.6, 20.5, 30.7; 34.2, 21.4; 40.0, 20.0; and 38.0, 35.8. Thus ^{90}Sr accounted for about 10% of the artificial radioactivity of honey. Data on systematic variation of artificial radioactivity of honey with climate and geographical location must await analyses of ^{137}Cs in honey. On the assumption of a per capita dietary intake of 30 g of honey per day, the daily ingestion of radioactivity from this source would be 9 to 12 pCi/day, a figure well below the permissible limit. (BBB)

15012 X-RAY DOSAGE FROM A CROOKES' TUBE. Parsons, Karl (Eastern Michigan Univ., Ypsilanti). Amer. J. Phys., 35: 890(Sept. 1967).

Investigation revealed that harmful doses of x rays were emitted in the proximity of a Crookes' tube under normal operating conditions. Film badge readings were taken at seven locations around the tube up to a distance of one meter. Exposure time was 16 min. for all locations. Highest intensities were recorded in front of the tube. Based on the data obtained, x-ray doses of 100 rem would be received during exposures of from 12 sec to 2.7 hr in front of the tube. This dose represents the USAEC maximum permissible dose in unrestricted areas. There are no state or federal regulations governing the use of a Crookes' tube. (E.R.B.)

15013 PERMANENTLY ENCAPSULATED THERMOLUMINESCENT DOSIMETRY APPLICATION IN MEDICINE AND BIOLOGY. Malsky, S. J.; Roswit, Bernard; Reid, Cyprian B.; Amato, Charles G.; Spreckels, Charles (Veterans Administration Hospital, Bronx, N. Y.). Med. Res. Eng., 6: 37-41(Third Quarter 1967).

The requirements for thermoluminescent dosimeters were discussed and several types investigated. An effective radiothermoluminescent system for in vivo dosimetry was developed for use

in therapeutic and diagnostic radiology and nuclear medicine, as well as in radiobiological and environmental health studies. Encapsulated, miniature out-gassed CaF_2:Mn dosimeters (1 × 10 mm) were used to detect 1-mR exposures. The estimated accuracy was +10% at the 3-sigma confidence level. Encapsulated LiF with the same dimensions (1 × 10 mm) and solid LiF crystals (2 × 2 × 10 mm) were also studied. The fluorimeter reader operated at room temperature and was designed to correlate the peak amplitude of the dosimeter's glow curve with doses over seven decades of range. Integrated values were also taken for further intercomparison at higher dosage levels. Several dosimeters were employed for each exposure. (BBB)

15014 INVESTIGATION ON ^{90}Sr FALLOUT IN THE NETHERLANDS OVER THE PERIOD 1958/65. Poelstra, P.; Frissel, M. J. (EURATOM-ITAL, Wageningen, Netherlands). Landbouwk. Tijdschr., 79: 100-5(Apr. 1967). (In Dutch).

Each spring since 1958 soil and grass samples were taken from four different soil types with differing Ca contents in permanent meadows and the fallout ^{90}Sr and Ca were determined. The quantity of ^{90}Sr measured in the soil was compared with the ^{90}Sr deposited as fallout. The measurements suggest that the deposition of ^{90}Sr over the profile occurs faster when the Ca content is higher. (tr-auth)

15015 CONTRIBUTION OF MEDICAL PRACTICE TO THE PROTECTION OF POPULATIONS FROM IONIZING RADIATION. Lin, S.; Scerrino, Enrico (Ospedale Maggiore, Trieste, Italy). Nuovi Ann. Ig. Microbiol., 17: 98-132(Mar.-Apr. 1966). (In Italian).

An account of physical parameters involved in production of the biological damage by ionizing radiation is given. Total dose absorbed by living tissues, spatial dose distribution, kind of radiations, and their RBE are discussed. The medical practitioner's contribution to defense from radiation somatic and genetic hazards is presented. In this program it is essential to ensure that any unnecessary radiological examination is avoided. Generally, the greatest contribution to the genetically significant dose comes from diagnostic radiology, especially x-ray examinations of pelvic organs which contribute 85 to 95% of genetically significant dose. Modern equipment and proper techniques are necessary to decrease the use of excessive radiation. Since fluoroscopic studies are more dangerous than radiographic examinations, some suggestions are given to diminish the dose to the patients during fluoroscopic examinations. In case of serious nuclear accidents the medical practitioner should be able to give first aid to the victims, recognize symptoms of the acute radiation syndrome, and aid in the containment of radioactive contamination. The participation of practitioners in civil defense is also discussed. (BBB)

15016 ASSAY OF ^{90}Sr IN HUMAN BONE IN UNITED KINGDOM. PART II. Monitoring Report No. 15. London, Her Majesty's Stationery Office, 1967. 24p. 3s.

Results of assays are given that were obtained mainly from subjects who died in the second half of 1966. Some further results for 1965 are also included. Results based on the analysis of vertebrae, in place of the femora used before 1966, were available over a whole year, and covered the full age range from newborn to adult. It is noted, however, that only in the adult is there likely to be any appreciable difference between the various bones of an individual. It was found that for young children the amount of ^{90}Sr in 1966 was markedly less than in the previous two years. Adolescents showed no marked change, attributable to the slower turnover of Sr in this age group. (UK)

15017 RADIOACTIVITY IN DRINKING WATER IN THE UNITED KINGDOM: 1966 RESULTS. London, Her Majesty's Stationery Office, 1967. 20p. 2s. 3d.

Data are given on the amounts of ^{90}Sr and ^{137}Cs found in selected drinking water supplies in UK in 1966. Also included are concentrations of some other radioactive isotopes in a few supplies. Reduction in fallout resulted in a reduced water sampling programme from 26 sources in 1965 to 19 during 1966. Only seven sources are included in the 1967 programme. Information is given on methods of sampling and analysis, boreholes and well waters, river-derived supplies, impounded waters, filtration processes, activity levels in rain water, and ^{90}Sr and ^{137}Cs ingested from drinking water. (UK)

15018 PROTON DOSE DISTRIBUTION MEASUREMENTS IN LOW ATOMIC NUMBER MATERIALS. Tanner, Raymond Lewis. Los Angeles, Univ. of California, 1967. 151p.

Thesis.

This study consists of two parts. The first describes a series of measurements of center line depth dose in a tissue-equivalent polystyrene phantom irradiated by parallel beams of monoenergetic protons having approximate energies of 20, 45, 138, 300, 590, 630, and 730 MeV. Included are data taken with 730 MeV beams degraded by 229 g/cm^2 of copper and by 199 g/cm^2 of carbon, yielding protons of nominal energy 260 and 220 MeV, respectively, but contaminated with high-energy nucleons and possibly gamma rays. A description of the extrapolation ionization chamber and other experimental equipment is included as well as a discussion of the necessary assumptions and calculations to convert the raw data to relative absorbed dose measurements in tissue. Physical parameters of the proton beams are listed. Results showing a steep initial rise in depth dose at the higher energies are compared with calculated curves as are the lower energy results which resemble Bragg curves. Some comments are made concerning the radiobiological and space radiation dosimetric implications of these measurements. The second part of this study presents a method of measurement of the microscopic dose distribution in a low atomic number phantom due to an incident proton beam. The volume in which the microdose distributions may be measured is a 5.1-cm-diameter, spherical, tissue-equivalent, gas flow, proportional counter. It is operated at reduced pressures thus simulating a tissue sphere as small as one micron in diameter. The response of the ruggedly designed counter to alpha particles and protons, as a function of path length in various portions of the chamber, shows it to have uniform gain characteristics. For very small energy absorption in the counter the observed pulse height distribution is quite large. Operation as an ionization chamber utilizing the field-shaping electrodes as guard rings shows the counter to be operating in a saturated condition well below the voltage region for proportional counter use, thus demonstrating high collection efficiency in both modes. Use of this counter for various proton energies is discussed, as is the need for counters of different shape and size in the study of basic radiobiological energy absorption processes. (Disser. Abstr.)

Medicine

Refer also to abstracts 14525, 14758, 14823, 14906, 14953, 14958, 15054, 15062, 15077, 15079, 15105, 15107, 15110, and 15123.

15019 (ORNL-TM-2091) TWO MEDICAL DIAGNOSTIC ISOTOPES, ^{68}Ga AND ^{99m}Tc: A BIBLIOGRAPHY. Stemple, Ruth M. (comp.) (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 15p. Dep. CFSTI.

Approximately 30 references on the use of ^{68}Ga and 300 references on the use of ^{99}Tc in the diagnosis and localization of tumors in the human body are presented. (H.L.W.)

15020 EXCRETION OF FREE FATTY ACIDS AND NEUTRAL FATS BY THE WALLS OF THE SMALL INTESTINE OF DOGS DURING ACUTE RADIATION SICKNESS. Shastin, R. N. (Kalinin State Medical Inst., USSR). Radiobiologiya, 7: 519-24 (1967). (In Russian).

Excretion of neutral fats and fatty acids was determined in six-month tests. Then seven dogs were irradiated on RUM-3 equipment at a voltage of 200 kV and a current of 15 mA with an 0.5 mm. Cu filter. The dose rate was about 5 R/minute and the total dose was 500 R. Studies showed that in radiation sickness the excretion of neutral fats and fatty acids increased and that the peaks excretion coincided with the overall disturbances of lipid exchange. The parallel between the neutral fat concentration in the intestinal juice and blood serum was disturbed, so that their excretion did not depend on their blood content. The excreted intestinal juice and fatty acids increased mainly at the expense of the liquid part of the juice and did not depend on exudation. (JPRS)

15021 TREATMENT OF CANCER OF THE ESOPHAGUS WITH AN INTRAESOPHAGEAL RADIOACTIVE PROSTHESIS. Ravasi, Gianni; Badellino, Fausto (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 53: 293-7(1967). (In Italian).

A new method employing radioisotopes was devised for radiotherapy of esophageal cancer. A special plastic prosthetic tube for treating esophageal stenosis resulting from cancer was described. It was a Mousseau-Barbin tube to which was fitted a hollow coupling containing a radioactive suspension. Radiophosphorus (^{32}P) in a colloidal suspension was used but possibly other, more penetrating isotopes could be used too. The method was simple to perform and the risks were negligible. Use of ^{32}P was superior to that of Ra because of less irradiation of surrounding healthy tissues. Thus the pure β emission of 1.71 MeV of ^{32}P, with a range of 2.25 mm, and the short half life of the isotope (14.3 days) permitted selective irradiation of the constricting cancer. This was a significant radioprotective feature of the described method. For demonstration of the location of the radiation source by scintigraphy, tracer amounts of the γ emitter ^{51}Cr were added to the dose (3 mCi in 4 ml) of ^{32}P used. (BBB)

15022 SOME CONTRIBUTIONS OF RADIATION CHEMISTRY TO THE UNDERSTANDING OF THE BIOLOGICAL ACTIONS OF IONIZING RADIATIONS. Stein, Gabriel (Hebrew Univ., Jerusalem). pp 164-71 of The Treatment of Cancer, With Special Reference to Radiotherapy and Chemotherapy. Mitchell, J. S. (ed.). Cambridge, Eng., University Press, 1965.

While the exact mechanism of the biological action of ionizing radiations in specific cases is not well understood, advances in the last two yr in understanding radiation chemistry have led to the establishment of clearcut mechanisms in some systems. If applied with sufficient caution, these advances in radiation chemistry could assist in an understanding of radiation biology. Some of these advances in radiation chemistry, in particular in the radiation chemistry of aqueous systems, are surveyed. Aqueous colloids, inorganic and organic, were affected by low doses of radiations. The stability of such colloids was determined by a relatively small number of surface charges. Experiments have showed that the microelectrophoretic properties of Ehrlich ascites tumor cells, as well as of a variety of mammalian cells cultured in tissue culture, were decisively changed by irradiation with low doses of radiations. At the same dose human erythrocytes were not affected. The results were interpreted by assuming that, in the case of the cells, positive charges on the surface were selectively eliminated. Thus indirectly the net negative charge was increased. This resulted in the increased negative electrophoretic mobility observed. The negative charges themselves were not affected in a comparable manner by irradiation. Accordingly, the erythrocytes, which have only negative, and no positive surface groups, were not affected at the low dose level employed. A very strong dose-rate dependence was observed, indicating that a possible mechanism consisted of electron (or O_2^-) capture by the surface positive charges in competition with the recombination of the solvated electrons with, e.g., OH radicals. This mechanism, if correct, would account for only one type of the biological action of radiations in which the appropriate radiation chemical model was possibly the behavior of colloidal systems explained in terms of the recent advances in knowledge of the fundamental radiation chemistry of aqueous systems. (BBB)

15023 CONTRIBUTIONS TO THE STUDY OF PROTEIN ELECTROPHORETIC PROPERTIES UNDER THE ACTIVITY OF IONIZING RADIATIONS AND CHEMICAL COMPLEXITY. Furnica, Gh.; Teodorescu, C. Stud. Cercet. Biochim., 10: 13-17(1967). (In Rumanian).

Protein solution ranging between 10^5 and 10^6 R were exposed to ^{60}Co γ radiations. The electrophoretic analysis revealed changes in the ionizable functions and macromolecular network. The globulins showed a higher radiosensitivity than albumin. The complexity of some small molecules, e.g., amino-ethylene-isothiuronium (AET) in proteins, partly dissimulates the dissociable functions, thus affecting the electrophoretic macromolecular migration. (auth) (Rom. Sci. Abstr.)

15024 THE RELATIVE BIOLOGICAL EFFECTIVENESS OF IONIZING RADIATIONS AND THE INDICATIONS FOR USING A ^{60}Co UNIT IN RADIOTHERAPY. Field, C. D. (Univ. of the West Indies, Mona, Jamaica). West Indian Med. J., 14: 224-9(Dec. 1965).

Radiobiological principles, especially those concerning RBE and LET, were reviewed in relation to the advantages of ^{60}Co γ radiation used in radiotherapy. The mechanism by which the energy of the ionizing radiation was transferred to the specific constituents of the organism and what quantity of it was transferred; the type and yields of radical and molecular products and their reactions with such biological molecules as enzymes, and genes, and other fundamental constituents of the cell; biochemical events resulting from the radiation damage of the biological systems; and the physiological aspects of the problem with regard to repair and recovery processes were discussed. The relation between RBE and LET for mammalian systems was examined in terms of indications for using a ^{60}Co source in radiotherapy. The LET of ^{60}Co γ rays was lower than that of the conventional (220-KV) x rays, the implication being that as the effectiveness of the radiation increased with increasing LET then the conventional, 220-KV x rays would be more effective in producing biological damage than the γ rays. Although ^{60}Co did not help increase the therapeutic ratio, it did offer advantages in getting the maximum dose to the tumor with minimum damage to normal cells. The advantages of ^{60}Co were summarized as follows: increased ease of concentrating radiation on the tumor, while sparing the normal tissue; less differential absorption between bone and the soft tissues; less radiation exposure of the skin, as the maximum dose occurred 3 to 5 mm below the surface of the skin; simplicity of apparatus; and less exit skin dose reaction than from higher energy radiations. (BBB)

15025 TUMORCIDAL EFFECT OF LASER RADIATION ON MALIGNANT TUMORS. McGuff, Paul E. (Laser Medical Research Foundation, Boston). Int. Ophthalmol. Clin., 6: 379-86(Summer 1966).

Ruby lasers with 0.5 to 360 Joules energy output were used in conjunction with a simple biconvex lens for focusing, giving up to 12,000 J/cm^2 when the 360-J energy output was emitted for 3 msec upon a 2-mm diameter focal spot. When tumors of human origin were transplanted into the hamster, six of eight of these tumors showed regression after laser irradiation. The six tumors that gave excellent results were three malignant melanomas, one thyroid carcinoma, one adenocarcinoma, and one myxofibrosarcoma. One tumor, a squamous cell epithelioma, gave moderate results, another tumor, a sarcoma of human origin, was the most resistant tumor of the 20 malignant types treated with laser energy. A lattice hypothesis of absorption capability of a tumor was proposed, and discussed in terms of how laser energy entered a tumor and the properties that determined its adsorptive capability. If the tumor was transparent, highly reflective, or white, the laser beam was hardly absorbed, and the biological effect was minimal. If the tumor was homogeneously black, a maximal amount of the laser beam was absorbed and reradiated from one "black body" to another, as through a lattice, thus spreading much more deeply into and through the tumor, and eventually causing cellular destruction and death. The white tumors did not respond well unless the surface was dyed with a color compatible with the absorption of red light. Pigmented tumors and translucent ones responded well to laser energy treatment. Reddish or highly vascular tumors responded poorly to ruby laser treatment. Characteristic histological sections of lased tumor specimens after the first to third week postlaser showed widespread necrosis, hemorrhage, thrombosis, organization, and repair. (BBB)

15026 RENOGRAPHY IN THE EVALUATION OF THE RENAL FUNCTION OF PATIENTS WITH TOXEMIA OF PREGNANCY. Laakso, L. (Univ. of Turku, Finland). Acta Obstet. Gynecol. Scand., 45: Suppl. 9, 106-8(1966).

Radioisotope studies of renal functions in normal and toxemic pregnant patients are reported, along with estimates of fetal radiation exposure. The tracer used, Hippuran-^{131}I was administered in a dose of 30 μCi to the mother, giving the fetus of three to five months a maximum irradiation dose of 0.5 mR to the gonads and 2 mR to the kidneys. The amount of irradiation to the gonads of the fetus in roentgenography is ~4 mR. In 27 normal parturients and 78 patients with toxemia of pregnancy, the Hippuran-^{131}I dose ante partum was 10 μCi and post partum 30 μCi. The examination was performed with two lead collimators and a 1.5 × 1 in NaI(Tl) crystal. The measuring field at the kidneys was 12 cm and the crystal-kidney distance 18 cm. The measuring range for 10 μCi was 10^4 cpm. The patient was given 10 to 15 drops of Lugol's solution about two hr before the examination to reduce thyroid uptake of ^{131}I. The results were consistent with p-aminohippurate (PAH) clearance studies. Both hippuran and PAH pass through the tubule cells by a similar mechanism. The examination described took 20 min, required no collection of urine, and the radiation exposure was small (1 to 2% of the radiation dose in intravenous urography). In the evaluation of the results, however, it was noted that renography was a screening test, the results of which had to be compared with those of other tests. (BBB)

15027 COMBINED IRRADIATION AND SURGICAL THERAPY FOR CARCINOMA OF THE CERVIX UTERI. Gray, Laman A.; Peterson, Gerald L.; Barnes, Malcolm L. (Univ. of Louisville, Ky.). pp 229-39 of Proc. 5th Nat. Cancer Conf., Sept. 17-19, 1964. Philadelphia, J. B. Lippincott, 1965.

Prevention of radioinduced complications in patients receiving tumoricidal doses of radiation to primary cervical cancers and lymph node metastases was considered. The continuing effort to increase the dose of irradiation in both deep therapy and local irradiation to the cervix was followed by very minor improvement in salvage rates, whereas the complications were progressively more numerous. Although some evidence indicated that lymph node metastases were found less commonly after irradiation, other reports did not substantiate this. It was evident that an appreciable percentage of cases continued to have carcinoma in lymph nodes after irradiation. Irradiation reactions were ignored or minimized by some authors, but one report indicated that among 580 patients who received Ra, either alone or in combination with x-ray treatments, 2.6% had severe reactions, 6.9% moderate reactions, and 90.5% mild reactions. Complications and cure rates in 27 cases were reported. Because complications after irradiation therapy were increased greatly after very high tumor doses to the parametria and to the cervix, relatively moderate doses were used. Yet in this group, nine cases received 6000 to 12,600 R to the cervix (and three died of cancer). Brawny induration of the abdominal walls and the buttocks followed ex-

ternal irradiation in several cases, especially the four treated with external ^{60}Co. A few had marked pelvic induration (three were improved by cortisone given months and years later), and edema of the legs was common. Two years later, one required resection of the terminal ileum for obstruction and gangrene. In this series, three developed pelvic abscesses, several had delayed voiding, several had recurrent urinary tract infections, but none had undue blood loss, vesical or ureteral fistulas, or lymphocele. There were no operative deaths. (BBB)

15028 RADIATION THERAPY FOR CARCINOMA OF THE CERVIX. Nolan, James F. (Univ. of Southern California, Los Angeles). pp 223-7 of Proc. 5th Nat. Cancer Conf., Sept. 17-19, 1964. Philadelphia, J. B. Lippincott, 1965.

The effects of 450-KV x rays and ^{60}Co teletherapy, both combined with intracavitary Ra treatment, on stage I cervical carcinoma were compared with respect to occurrence of complications and clinical results. There seemed to be a definite superiority for those treated with megavoltage therapy, but it was thought that this superiority was not due to the differences in the physical characteristics of the radiations alone. However, the superior physical features of the megavoltage radiation did allow for a more uniform technical application of external radiation to practical levels of dosage. This, in turn, decreased the necessity for intense local irradiation with its inherent dangers. The incidence of complications in relation to technique and dose was evaluated. With early tumors treated with generally modest levels of exposure there were no major complications, such as fistulas, severe proctitis or cystitis, or local necrosis. In the latter cases especially, extremely high or low doses were avoided in an attempt to maintain uniformity rather than to explore the reactions to extremes of dosage. Only one patient, treated with interstitial needles to the cervical stump, received an extremely high calculated dose. (BBB)

15029 TRENDS IN RADIOTHERAPY OF BREAST CANCER. Vermund, Halvor (Univ. of Wisconsin, Madison). pp 183-204 of Proc. 5th Nat. Cancer Conf., Sept. 17-19, 1964. Philadelphia, J. B. Lippincott, 1965.

Radiobiological principles applicable to the radiotherapy of breast cancer are reviewed, with 153 references, and advances in such radiotherapy are surveyed. The significance of hypoxia as a factor responsible for the radioresistance of tumors was examined. A variety of malignant tumors have been exposed to irradiation under hyperbaric oxygen, and there was mounting evidence of increased radiosensitivity under these conditions. Many other chemical modifiers of radiation effects have been studied, and some found useful on an experimental basis in the treatment of malignant tumors in patients. In radiobiological considerations of recent trends in radiotherapy, the problems of achieving an optimal dose-time relation and fractionation schedule assumed great importance. How the therapeutic effect of any dose of radiation depended on the time over which the irradiation was administered was discussed. The finding that the recovery of breast cancer, when treated daily for five days a week with equal daily doses, was at least as great as that of normal skin, suggested that there was no advantage of prolonged fractionation of the irradiation for this type of tumor because the therapeutic ratio did not increase with protracted irradiation. These data correlated well with values calculated from 29 different publications on results of radiotherapy of breast cancer which gave a medium lethal dose resulting in a 50% cure rate of 1200 R and a recovery exponent of 0.33 for orthovoltage (200-KV) radiation. The RBE of this type of radiation was estimated to be about 1.5 times that of γ rays. Evidence obtained through clinical observations that the size, spacing, and frequency of the radiation treatments influenced the response of breast cancer was also considered. There appeared to be a critical interval between radiation treatments at which the therapeutic ratio was optimal, which could be explained on the basis of differences in the critical phases of recovery from radiation effects taking place in tumors and adjacent tissues. Although there appeared to be an advantage in extending the total duration of the treatment course in squamous cell carcinomas, such prolongation could be disadvantageous in adenocarcinomas of the breast. On the basis of radiobiologic theories it was recognized that irradiation in sufficiently high doses reduced the tumor cell population which, when reaching a critical low level, would become restrained by host tissue resistance and be maintained in a dormant state for an indefinite period. (BBB)

15030 RADIOTHERAPY OF PROSTATIC CANCER. Takai, Shudo; Yamashita, Gentaro; Igawa, Kin-ichi; Wada, Tomiyuki; Tamiya, Takahiro (Sapporo Medical Coll.). Tumor Res., 1: 77-102(June 1966).

Experiments were conducted in dogs to determine the dose and distribution of radioisotopes required for destroying prostatic tissue, and the clinical effects of radiotherapy on prostatic cancer patients were investigated. In some dogs two to four needles of ^{60}Co (3 mCi) were inserted in the prostatic tissue for four days, being placed parallel and 1 cm apart. In the second group, two to three ^{182}Ta wires (2 to 3 mCi) were inserted for four days in the same way. In the third group, a colloidal solution of $Cr^{32}PO_4$ (2 ml, 2 mCi/ml) was injected into prostatic tissue. Histological examinations were made every week for five weeks. The results indicated that from 10,000 to 20,000 R should be delivered to prostatic tissue to destroy the gland and that the inflammatory changes in the tissue subside within five weeks. Fourteen prostate cancer patients were similarly treated. The irradiation period in the interstitial use of ^{60}Co needle was from 72 to 168 hr and the estimated irradiation dose was from 15,300 to 35,700 R. Periurethral application of ^{60}Co needle or ^{182}Ta wire was by insertion of the needle or wire in the lumen of an indwelling catheter for 48 to 216 hr for a total dose of from 3825 to 25,450 R. With $Cr^{32}PO_4$ solution, 0.5 ml was injected for each gram of tissue, or a total of 5 to 10 ml corresponding to the volume of the cancer tissue. In all patients with interstitial insertion of ^{60}Co needles after extensive antiandrogenic therapy, the size and consistency of the tumor were markedly decreased. Side effects such as contracted bladder and urinary infection were found in two of the three cases. In patients with periurethral irradiation, marked changes in the tumor were not seen. However, obstruction of the prostatic urethra was eliminated. Biopsy or autopsy specimens of the patients with interstitial ^{60}Co needles showed extensive necrosis and degeneration. However, some degenerated or active cancer cells were found in the peripheral region of the tumor. Biopsy specimens taken one month after the injection of $Cr^{32}PO_4$ solution showed no evidence of cancer in three of the four cases examined. It was concluded that patients over 70 yr of age with early localized prostate cancer and patients with early but not operable prostate cancer should be treated with interstitial injection of colloidal solution of $Cr^{32}PO_4$. Patients with advanced prostate cancer even after extensive antiandrogenic therapy should be treated with interstitial insertion of ^{60}Co needles or ^{182}Ta wire. It was most important in radioisotope therapy to distribute the radioactive material in the cancer tissue as completely as possible. (BBB)

15031 THERAPEUTIC UTILIZATION OF RADIOACTIVE ISOTOPES IN PITUITARY SURGERY. Talairach, J.; Szikla, G.; Bonis, A.; Bancaud, J.; Schaub, C. (Hopital Sainte-Anne, Paris). Int. J. Neurol., 5: 78-93(1965).

The use of ^{90}Y, ^{60}Co, ^{198}Au, ^{182}Ta, and ^{192}Ir for destruction of the pituitary in 350 patients is described, with data on doses used, clinical and histological effects, brain damage and other complications. In the selective destruction of the pituitary gland by β-emitting isotopes, focal doses of radiation necessary to produce acute necrosis of the hypophysis were estimated to be 100,000 to 140,000 rad. The sensitivity of neighboring structures, such as oculomotor nerves, optic chiasma, and hypothalamus, limited the upper level of radiation reaching these structures to ~5000 rad. External x irradiation or interstitial γ therapy could not achieve such spatial selectivity at a ratio of 20:1, so that use of β radiation with a very steep absorption curve was necessary. Because of its limited necrotizing effect, the exclusive β radiation of ^{90}Y permitted selective destruction of the pituitary gland without damaging adjacent structures. Utilization of γ-ray emitters was contraindicated for this purpose as they could not attain such spatial selectivity. However interstitial radiotherapy with γ sources was indicated for deep-seated well-localized and limited target volumes, where locally high doses could be given without exceeding the tolerance limits in surrounding sensitive structures. Geometric disposition of sources had to be adapted to each case by carefully estimating doses, taking into consideration the threshold doses for late irradiation necrosis of the brain. To establish the limits of cerebral radiotolerance a study was made of intracerebral implantation of radiogold, where late necrosis appeared several months, often years, later. Clinical changes and histological findings in 13 brains were examined in relation to doses. It was found that after >12,000 to 14,000 rad, delayed necrosis was homogeneous and total. After doses of between 4,000 and 12,000 rad, severe tissue alterations were found, consisting of partial necrosis of structures along with a glial reaction. Between 1,000 and 4,000 rad, sporadic alterations were encountered, especially around blood vessels, in tissue with normal appearance. (BBB)

15032 EXTRACORPOREAL IRRADIATION FOR TREATMENT OF LEUKEMIA AND FOR IMMUNOSUPPRESSION. Cronkite, Eugene P. (Brookhaven National Lab,. Upton, N. Y.). Ann. Int. Med., 67: 415-23(Aug. 1967).

Techniques, side-effects, and clinical results of extracorporeal irradiation of the blood and lymph (ECIB and ECIL) are reported, as used to treat acute myeloblastic (14 cases), chronic granulocytic (five cases), and chronic lymphocytic leukemia (11 cases).

In all patients the blood leukemic cell concentration was diminished for varying periods of time. In the chronic leukemias the drop in blood counts might be precipitous, with concomitant increase in uric acid excretion and variable diminution in organomegaly. In some cases of chronic lymphocytic leukemia the platelets increased, transfusion requirements diminished or disappeared, and, in general, the patient's well-being seemed improved. In no case was bone marrow remission observed. The median survival time of patients with acute myeloblastic leukemia was slightly longer than afforded by chemotherapy. No general toxic effects, as encountered with chemotherapy and general radiation therapy (^{32}P or whole-body radiation), or no local damage, as seen after extensive splenic irradiation, were noted with ECIB. ECIB and ECIL were also being applied in preparation of patients for renal allografts and treatment of rejection crises, but lasting beneficial effects in immunosuppression had not yet been demonstrated. ECIB was being applied in at least three clinics in the management of leukemia. The most promising role of ECIB might be in treatment of chronic lymphocytic leukemia when cases had become refractory to drugs, and it might be the preferential therapy for the early disease. (BBB)

15033 CYSTEAMINE: DIFFERENTIAL X-RAY PROTECTIVE EFFECT ON CHINESE HAMSTER CELLS DURING THE CELL CYCLE. Sinclair, Warren K. (Argonne National Lab., Ill.). Science, 159: 442-4(Jan. 26, 1968).

Cysteamine present during x irradiation protects synchronized Chinese hamster cells in culture against lethal damage at all stages of the cell cycle. The effect is greatest for cells irradiated at sensitive stages such as G_1 and least for resistant cells; for example, late S (dose-modifying factors 4.2 and 2.7, respectively). The effect of 50 millimolar cysteamine is to render almost invariant the normally variant x-ray response for lethality. This suggests that there are two components of x-ray damage, only one of which is age dependent, and it is against this component that cysteamine protects the cell. Cystamine, however, has no protective effect upon these cells at any stage of the cell cycle. (auth)

15034 CLINICAL CORRELATIONS OF ^{203}Hg-CHLORMERODRIN AND URINARY CONCENTRATION IN HYPERTENSION AND RENAL DISEASE. Murphy, Gerald P.; Schirmer, Horst K. A.; Johnston, Gerald S.; Morris, Russell A. (Johns Hopkins Hospital, Baltimore). J. Urol., 98: 163-6(Aug. 1967).

Clinical confirmation is presented of animal data that gave evidence for the validity of the use of ^{203}Hg-chlormerodrin urinary concentration in renal ischemic hypertensive states as a simple means of assessment of the degree of unilateral proximal tubular function impairment. In the clinical evaluation of patients with hypertension, an intravenous injection of 30 μCi ^{203}Hg-chlormerodrin was given at the termination of split function tests performed during parenteral hydration. After a 30- to 45-min mixing time, urine was obtained and counted in a well counter. Histological evaluation of operatively removed renal tissue was also correlated with renal cortical and medullary ^{203}Hg-chlormerodrin concentration in some cases. (BBB)

15035 DELAYED REACTIONS IN POSITIVE PHOTOPATCH TESTS TO HALOGENATED SALICYLANILIDES. Ison, Arnold E.; Tucker, Joseph B. (Univ. of Miami, Fla.). Arch. Dermatol., 96: 59-61(July 1967).

The effect of uv irradiation was studied by patch testing in a patient sensitive to halogenated salicylanilides present in soaps. Delayed positive reactions were noted in uv photopatch tests with dibromosalicylanilides (DBS) and tribromosalicylanilides (TBS) that were incorporated into several widely used soaps as antibacterial agents. Patch tests were applied in duplicate sets and were removed after 48 hr. One set was irradiated using a 100-w Wood's light with ordinary window glass replacing the purple filter. The lamp-to-skin distance was 14 in. and the exposure time 7 min. This light was a powerful source of long-wavelength uv radiation. At 8, 12, and 24 hr after irradiation no changes were noted. At 96 hrs, puritus occurred in the area of patch testing, with positive reactions on the irradiated side only to DBS, TBS, and tetrachlorosalicylanilide. The positive reactions began at 96 hr with erythema; induration and papulovesicles developed and reached maximum intensity within seven days. (BBB)

15036 A NEW LOOK AT RADIOIODINE THERAPY OF THYROTOXICOSIS. New Engl. J. Med., 277: 596-7 (Sept. 14, 1967).

The increasing incidence of hypothyroidism as a complication of the ^{131}I treatment of Grave's disease has necessitated more caution in the radioisotope treatment of this disease. Initially it was expected that some patients treated with radioiodine, like those treated surgically, would subsequently develop hypothyroidism, but the frequency of this complication was thought to be acceptably small. In many reports that appeared before 1960, hypothyroidism occurred with a modal frequency of ~10%, most cases becoming manifest within a year or two after treatment. A tendency for the frequency to increase with time was then noted, necessitating a re-evaluation of both the indications for and method of utilizing radioiodine therapy. Reports after 1961 indicated that the frequency of postradioiodine hypothyroidism is not only greater than originally thought but continues to increase at the rate of several percent per year, reaching about 30% at 10 yr. In some clinics, a frequency as high as 45% in two yr and 70% in 10 yr was observed. In a new approach to this problem, only half the usual dose of radioiodine is administered. Although this may be insufficient to produce early control of thyrotoxicosis, its delayed effects may produce control after months or years. In the interim, thyrotoxicosis can be controlled, either with iodine or with propylthiouracil. This results in no loss of the long-range efficacy of radioiodine, but a sharp reduction in the incidence of hypothyroidism. It is recommended that a regimen of this type should replace conventional radioiodine therapy where it is indicated in the treatment of thyrotoxicosis. (BBB)

15037 ANALYSIS OF CONTEMPORARY CONCEPTS OF THE PHYSICOCHEMICAL MECHANISMS OF THE OXYGEN EFFECT IN RADIATION INJURY. Eidus, L. Kh. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 678-87(1967). (In Russian).

The literature on the subject is surveyed and discussed. It is concluded that the modifying influence of oxygen is connected with its action on radiation products with saturated valences—"water" or impurity radicals or ionized macromolecules with latent damage, one sign of which is long stability with unpaired electrons. The physical mechanisms by which the oxygen effect is accomplished are still not clear. Analogies of the effects of oxygen and nitric oxide indicate that the influence of oxygen is conditioned by the paramagnetism of molecules of gases which represent radicals in the fundamental unexcited state, which is correlated to the fact that they interact only with radical states of molecules. (JPRS)

15038 EFFECTS OF RADIOPROTECTIVE CHEMICALS ON THE HISTOPATHOLOGIC CHANGES IN ORAL RADIATION DEATH IN MICE. Goepp, Robert A.; Fitch, Frank W. (Univ. of Chicago). J. Dent. Res., 46: 571-8(May-June 1967).

Differences between chemically protected and nonprotected mice irradiated with 1800 R to the head were studied by daily examination of the gross and microscopic structure of the tongue and oral cavity. Systemic administration of aminoethylisothiuronium (AET) and p-aminopropiophenone (PAPP) was found to ameliorate the radioinduced lingual ulceration after doses of irradiation that can cause oral radiation death. Lingual tissues of the chemically protected mice had fewer or less severe radioinduced changes than tissues of unprotected mice. The rate of radiation atrophy of the lingual epithelium was slower in chemically protected mice than in the nonprotected mice. Chemical protection, however, did not appreciably alter early radiation effects. The tongues of chemically protected mice showed either a sudden surge of epithelial proliferative activity about seven days after irradiation or mild ulceration about nine days after irradiation. In either instance, an apparently intact epithelium was present on the dorsum of the tongue about 11 days after irradiation in chemically protected mice. Examination of other organs in irradiated, nonprotected mice showed changes usually found in earlier studies of oral radiation death. Size and weight of the thymus, liver, and spleen were decreased on postirradiation day 7, and 9 days after irradiation weight loss in these organs had reached 25 to 40%. There was depletion of cells in lymphoid tissues; in the liver parenchyma, cells were decreased in size with increased cell density per unit area. The changes in protected mice were less severe. (BBB)

15039 TREATMENT OF CARCINOMA OF THE BUCCAL MUCOSA BY A COMBINATION OF EXTERNAL ORTHOVOLTAGE RADIATION AND AN INTRA-ORAL RADIUM MOLD. Pinto, J. M. (Tata Memorial Hospital, Bombay). Indian J. Cancer, 4: 27-31 (Mar. 1967).

A technique is described for radiotherapy of small oral cancers that prevents injury of healthy tissues and provides for a low complication rate. Results with its use in 42 patients are presented. All were treated as outpatients by a combination of external orthovoltage x radiation and an intraoral Ra mold. The x-ray dose was between 3000 and 4000 rad in 12 to 16 daily fractions of about 250 rad each, the treatment being completed in about three weeks. On completion of external irradiation and provided the lesion had regressed and flattened out, as seen in a few cases after 2500 rad, an intraoral mold was made of an ordinary dental compound. The lesion, with a margin of about 1 cm, was treated with doses of between 3000 and 4000 rad at the surface. Thus, the total doses to the buccal mucosa were between 6000 and 8000 rad,

the precise dose being based mainly on the clinical regression of the lesion and the appearance of a confluent fibrin reaction on the mucosa. Intraoral x radiation on Ra molds could only be used for small and/or superficial lesions which were centrally situated. External radiation in the orthovoltage range was not to be recommended for a curative approach on account of the severe skin reactions that were likely to be produced, but supervoltage radiation in the 2-to-6 MeV range or γ radiation with ^{60}Co with a wedge technique was ideally suited for localized lesions, particularly those encroaching on the alveoli or the interalveolar ridge where the absence of differential absorption in bone helped avoid necrosis. Radium implants were useful in small to moderate-sized lesions but dose distribution often presented a problem. The intraoral Ra mold described irradiated uniformly a fairly well defined section of tissue containing the tumor, if any, and the tumor bed and spared the skin because of a rapid fall off in dose. There were no complications of such treatment; the skin and mucosal reactions healed in about three to four weeks. Late sequelae were dryness and loss of taste in the mouth and inability to eat hot, cold or spicy foods. (BBB)

15040 THE ROLE OF ANTIOXIDANTS (SYNTHETIC REDUCED GLUTATHIONE, TACHIONE) IN INDUCING MORTALITIES OF MICE AND DOGS DUE TO THE RADIOISOTOPE ^{198}Au AND HEMORRHAGIC SHOCK IN AN HYPERBARIC ENVIRONMENT. Umemura, Hiroya; Kuyama, Takeshi; Matsuda, Susumu; Kinoshita, Kenichi; Satomura, Kisaku; Yoshida, Yoshiyuki (Kyoto Univ.). Nippon Geka Hokan., 36: 174-9 (Mar. 1, 1967). (In Japanese).

Large doses (250 mCi/Kg) of radiogold ^{198}Au were given intraperitoneally to 40-day-old mice of the ddS strain in an hyperbaric environment. The injection of glutathione (Tachione), before the exposure to increased ambient pressure, seemed to reduce mortality in the mice due to the oxygenation and/or irradiation of the cells 10 days after the procedures were instituted. Also the synthetic glutathione (Tachione) was injected with plasma expanders, such as low molecular weight dextran, after hemorrhagic shock in dogs caused by bleeding the dogs, followed by the hyperbaric oxygen therapy. This treatment seemed to enhance the effect of hyperoxygenation in the erythocyte-depleted dogs. (BBB)

15041 TREATMENT OF RADIATION SICKNESS. Hulse, E. V. (Medical Research Council, Harwell, Eng.). Brit. Med. J., 2: 494 (Aug. 19, 1967).

An experimental technique for measuring the effectiveness of drugs attenuating the symptoms of radiation sickness is presented. Rats cannot vomit, but relatively low doses of radiation produce a delay in gastric emptying. This phenomenon was investigated by feeding them a thick paste of a commercial barium meal preparation before irradiation and then following the emptying of the stomach by serial radiographs. The technique could be adapted to study the effects of radioprotectors and sensitizers, and pyridoxine was tested in this way. Rats were injected intraperitoneally with 50 mg of pyridoxine hydrochloride in 1 ml of saline and were irradiated with 50 rad of x rays. Other rats were mock-irradiated so that separate comparisons could be made of the effects of radiation and pyridoxine. Determinations were made of the rate at which the stomach emptied during the 8 hr after irradiation. Pyridoxine by itself, in the dose used, delayed gastric emptying as much as 50 rad of x rays, and when the two were combined the gastric delay was greater than with either alone. Thus pyridoxine did not counteract the effects of radiation on gastric movement in the rat. If it could be assumed that gastric delay was the counterpart of radioinduced nausea and vomiting in man, this experiment would suggest that pyridoxine was not likely to counteract this effect of radiation. (BBB)

15042 ON THE UV-RAY TREATMENT OF VIRUS-CAUSED CORNEAL INFLAMMATIONS. Koleszar, G.; Molnar, L.; Juhasz, L.; Tatrai, K.; Toeroek, I. (District Hospital, Debrecen, Hungary). Klin. Monatsbl. Augenheilk., 147: 755-9 (Dec. 1965).

The wavelength range of uv irradiation that affected living organisms most and produced the greatest biological effects was from 2800 to 3200 Å. In the eye the cornea and conjunctiva absorbed the uv irradiation, releasing thermal energy that produced tissue lesions. These effects were modified by exposure time and by the wavelength used. At 250 mμ the critical dose of irradiation was 4.0×10^4 erg/cm^2, and at 275, 300, 325, and 350 mμ, it was 9.0×10^4, 59.5×10^4, 77.4×10^4, and 450.0×10^4 erg/cm^2, respectively. Taking the dose at 250 mμ to have a hazard factor of unity, the same factor at the other wavelengths specified amounted to 0.45, 0.068, 0.052, and 0.009. At high temperatures the herpetic keratitis agent was rapidly inactivated in acid medium by uv irradiation. (BBB)

15043 CASES OF LEUKEMIA AMONG THE ATOMIC BOMB SURVIVORS IN HIROSHIMA CITY DURING PAST 16 YEARS (1946–1961). Watanabe, Susumu; Hirose, Humio; Takisawa, Shioichi (Hiroshima Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 162-5 (Dec. 1963). (In Japanese).

The incidence of and mortality rate from leukemia among the atomic bomb survivors, within a 5000-mile radius of the hypocenter, in Hiroshima were studied. Leukemia occurred at a low rate in 1946 (1.01 cases/100,000 population), gradually increased after 1947, and reached a maximum in 1951 to 1953 (17.37/100,000 population) then gradually decreased (10.48/100,000 in 1961). Mortality from leukemia in 1946 (1.01/100,000) gradually increased from 1947 (3.04), reached a maximum in 1956 (14.49), then gradually decreased (11.52 in 1961). In first 8-yr and second 8-yr periods from 1946 to 1961 the acute type of leukemia occurred in 48 and 54 cases respectively and the chronic type in 35 and 37 cases. Therefore, no significant difference in the distribution of leukemia type in these two periods was observed. During the 16-yr period there were 102 cases of acute and 72 cases of chronic leukemia. The correlation between the leukemia incidence and the distance from the hypocenter was also studied. The survivors within a radius of 2000 miles showed the highest incidence of leukemia. Many cases of chronic myeloid leukemia were observed. The proportion of acute and chronic leukemia at various distances from the hypocenter was 1 : 0.78 at 2000 miles and 1 : 0.12 at 5000 miles. Among 30 leukemic subjects who entered Hiroshima 1 week after the bombing, the ratio for acute and chronic type was 1 : 1.73, representing a difference from the ratio in those directly exposed to the detonation. (BBB)

15044 PRACTICAL VIEWPOINTS IN THE TREATMENT OF MAMMARY CARCINOMA. SURGERY, RADIOTHERAPY, HORMONAL THERAPY, AND CHEMOTHERAPY. Schweingruber, B.; Fridrich, R.; Bollag, W. (St.-Clara-Spital, Basel). Praxis (Bern), 54: 1361-7 (Nov. 18, 1965). (In German).

If no more than two fields were irradiated daily for eight or 10 weeks with 200 R of x ray or 300 R of ^{60}Co, then the general condition of the patient with mammary carcinoma was not affected. In aged patients the tumor dose was given in three series, with two- or three-month intervals between series. The use of ultrahard irradiation from ^{60}Co produced much less severe complications, and irradiation catarrh was rarely produced. Psychological factors should be considered in treatment of irradiation effects, as well as antiemetics and vitamins. With ultrahard irradiation the dose maximum occurred ~5 mm below the skin surface, and skin reactions to irradiation were decreased. The moist reaction of irradiated skin could be treated with drying powders, and additional irritation from sunlight, warm covers, diathermy, and soaps had to be avoided. Salves might be necessary for treatment of moist skin reactions. Irradiation pneumonitis might accompany irradiation of the mammary area or the lymphatic drainage areas because of their proximity to the lung tissues. This was indicated by dyspnea, a relatively nonproductive cough, and subfebrile temperatures. It could be demonstrated roentgenologically two to six weeks after irradiation by a lung picture with more or less dense, poorly defined confluent shadowings, largely restricted to the section of lung irradiated. Treatment with antibiotics and steroids cleared up the clinical symptoms, although a fibrotic induration might remain in the lungs. (BBB)

15045 START OF AN EXACT IRRADIATION PLANNING. STEREOLOCALIZATION AND ELECTRONIC CALCULATION OF THREE-DIMENSIONAL DOSE DISTRIBUTIONS. Rosenow, U. (Univ., Goettingen, Ger.). Arch. Gynaekol., 204: 50-2 (1967). (In German).

Electronic calculation of dose distribution of percutaneous or intracorporal irradiations required solutions to problems of localization and spread of tumors of focal areas, position, spread and characteristics of inhomogeneities in the radiation beam, localization of intracorporally applied solid radiation sources, and the position and extent of healthy organs in the region of the tumor area. An accurate, simple procedure for evaluation of stereoscopic x-ray images that used a point-source of light reflected in a stereoscopic image, with a maximum uncertainty of 0.1 mm in defining a point in space, was discussed. The orthogonal projection of the spatial path in one of three major planes could be traced. The method was reported to be superior to all other three-dimensional x-ray localization methods, such as tomography, photography with an orthogonal radiation beam or with tube shift, and stereometry. Its value was demonstrated for sectional images for measurement of inhomogeneities (bones), determination of orientation of the bony pelvis in prone and supine positions, and localization of a Ra insert in the uterus after lymphography for administration of the Ra dose to left and right lymph nodes. Homogeneous two-dimensional irradiation of the uterus in four fields and pendulum irradiation of the parametria in four small angle fields were calculated for three dimensions. (BBB)

15046 STATISTICAL OBSERVATIONS ON CLINICAL EXAMINATIONS OF ATOMIC BOMB SURVIVORS. III. SCREENING EXAMINATION FOR LUNG CANCER. Miura, Motoi (Committee for Statistical Survey of the Atomic Bomb Explosion, Hiroshima); Kachuta, Sizutomo; Miyanishi, Michihiro; Kumasawa, Toshihiko; Ogasarawa, Seitoku; Takemoto, Chuyoshi. Nagasaki Igakkai Zasshi, 40: 680-2(Aug. 1965). (In Japanese).

From May 1963, to September 1963, a total of 25,820 men and women were selected randomly from among 56,651 atomic bomb survivors and their chests were examined by x rays. In first examination of these 25,820 atomic bomb survivors, 562 cases (2.2%) showed frank tuberculosis and 211 other cases (0.8%) showed tuberculosis with possible lung cancer. There were 87 cases (0.3%) with other radiologic signs of respiratory diseases. The 211 cases of questionable lung cancer seen on the first examination were re-examined by more intensive x-ray diagnostic means. On the second examination, 8 males and 2 females were still considered possibly to have lung cancer, while 77 cases were found to have tuberculosis and the remainder to have other respiratory diseases. Of the 19 cases of doubtful lung cancer from the second examination, 3 had been exposed to the atomic bomb explosion at a distance of 1 to 1.9 Km from the hypocenter, 2 cases at a distance of 2 to 2.9 Km, and 3 cases at a distance of 3 to 3.9 Km; 1 case was at more than 4 Km and 1 case was an entrant into the city after the explosion. There seemed to be no correlation between the occurrence of lung cancer and the distance from the atomic bomb explosion. (BBB)

15047 EFFECT OF HOT SPRING BATHS ON γ-RAY DISTURBANCES. Yamada, Tomiko (Kyushu Univ., Japan). Nagasaki Igakkai Zasshi, 40: 644(Aug. 1965). (In Japanese).

The effects of hot spring balneotherapy on radioinduced disorders were investigated in 2.5 Kg adult rabbits that were γ-irradiated at a 500-R dose and then given hot baths (10 min duration) each day for two weeks. The results were compared with those of nonbathed controls and a cysteamine-injected (25 mg/Kg per day for 7 days) group. The body weight of the ^{137}Cs-irradiated nonbathed group decreased in the first three days after irradiation, then, during the four- to six-day period it increased and became stable afterward. Similar results were observed in the cysteamine-injected group. The hot spring bath-treated group showed only a slight decrease in body weight after irradiation and it increased at 11 to 12 days. The serum thiol level in the control group was decreased the first day after irradiation and then returned to normal in one to two weeks. The cysteamine-injected group showed similar results. The bathed group showed large variations and the altered values returned to normal in two weeks. The bone marrow leukocyte count in the control group was decreased in the first day after irradiation and did not return to normal in two weeks. In the cysteamine-injected group it was restored in two weeks and in the bath-treated group in one week. (BBB)

15048 ATOMIC BOMB CASUALTY COMMISSION. Gould, S. E. (Atomic Bomb Casualty Commission, Hiroshima). Bull. Pathol. (Chicago), 8: 58(Mar. 1967).

The organization, function, and findings of the ABCC are briefly reviewed. The three major programs being conducted at ABCC are the Life Span Study, the Adult Health Study, and the Pathology Study. The subjects in these studies are persons selected from among those who were exposed to atomic radiation, placed in groups according to their distance from the hypocenter at the time of the blast; and an equal number of nonexposed persons, matched with those who had been exposed, for age and sex. The sample in the Life Span Study and the Pathology Study numbers 100,000; whereas that of the Adult Health Study consists of 20,000 persons selected from that number. Other studies include incidence of cataracts, and incidence of leukemia and of other malignant disease among survivors; genetic follow-up of 72,000 children who were born in the two cities between 1947 and 1953; and growth and development of exposed children. The Pathology Study of diseases and of causes of death is based principally upon the findings of autopsies and biopsies. A Tumor Registry is in operation in each of the two cities. To date ~600 scientific reports from the ABCC have been published. (BBB)

15049 ABNORMAL FORMATION OF VISUAL ORGANS OF AMPHIBIAN LARVAE INDUCED BY RADIOACTIVE RAINWATER. Nishimura, Kenji (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 16: 263-7(Jan. 1967).

After the nuclear tests at Bikini Island in March 1954, and Nevada in April 1955, rainwater that contained radioactivity was collected. Rana nigromaculata gastrulae at the early or intermediate stage were maintained for 13 days in the radioactive rainwater, having an activity of 1.4 to 28 μCi/l. About 80% survived and those that did showed marked abnormalities externally or internally. Abnormalities especially in the formation of the eye were seen, besides abnormalities in the position of the viscera. Other embryos of the same kind and at the same stage of growth were placed in solutions of fission products at 20, 4, and 1 μCi/l and of $^{45}CaCl_2$ at 500, 100, and 20 μCi/l. However, there no external or internal changes in embryo development or in eye formation. (BBB)

15050 PROBLEMS OF TREATMENT OF CAVERNOUS HEMANGIOMAS IN CHILDREN. Wulf, K.; Memmesheimer, A. R. (Hautklinik des Stadtkrankenhauses, Kassel, Ger.). Deut. Med. Wochenschr., 92: 384-6(Mar. 3, 1967). (In German).

Bone growth injuries in children following administration of doses of 200, 450, or 2000 R of x irradiation for treatment of cavernous hemangiomas were reported in ~20% of the cases treated. Foci of bone growth inhibitions also were observed within five to 17 yr after irradiation treatment. Treatment of cavernous hemangiomas located in the region of the eyelids with irradiation requires especial precautions because of the possibility of induction of lens opacities. Brain damage may result from irradiation in areas above the open fontanelle, x irradiation treatment of hemangiomas located in the juvenile mammary areas or scrotal area is contraindicated, and any irradiation of the gonadal area is absolutely to be avoided. One method that is particularly suitable for treatment of all of the essentially surface hemangiomas is irradiation with $^{90}Sr-^{90}Y$ applicators. This method is useful for hemangiomas that extend downward for ~1½ mm. The treatment dose sequences that have been suggested are 250 rep, given at four week intervals for a total of 2000 rep, or 400 to 600 rep given every four weeks until disappearance of the hemangioma, with a maximum total dose of 3000 rep permitted. Particular attention should be given to all radiation protection measures that are necessary when this type of applicator is used. (BBB)

15051 HEAVY CHARGED PARTICLES IN CANCER THERAPY. Tobias, Cornelius A. (Univ. of California, Berkeley); Todd, Paul W. Nat. Cancer Inst. Monogr., No. 24, 1-21(Feb. 1967).

Applicability for cancer treatment and biological effects of heavy charged particles are discussed. The therapeutic advantages and disadvantages were compared with those of conventional x and γ rays. Heavy-ion beams were potentially the most suitable of all radiations to deliver a high localized dose to any deep region of choice in the body. The main therapeutic advantages of heavy-particle beams were the relatively straight beam, depth control, low entrance dose and Bragg ionization peak, and high LET. The LET dependence of certain biological effects was examined as to the requirements for a beam of heavy particles optimized for therapy. A characteristic acute survival curve for radiation of a given LET was shown and the damage analyzed into separate components: direct lethal damage, owing to the deposition by a single particle of sufficient energy in a strategic location in the cell and expressed as the initial slope of the survival curve; and a reversible component, due to the accumulation of sublethal lesions, the occurrence of each of which could be an expression of the component of the final slope. The oxygen effect decreased from its maximum value of about three for x rays to about two for radiations with LET of about 150 MeV-cm^2/g and about 1.5 for radiations with LET of about 300 MeV-cm^2/g (fast neutron and meson secondaries, respectively). This factor was less than 1.1 for radiation with LET greater than 2000 MeV-cm^2/g. Range to energy relations for some particles as a function of the energy per nucleon were shown. For example, the center of the human head could be reached by an Ar^+ particle of 500 MeV per nucleon. Problems which might be encountered in the use of 300-MeV/amu ^{20}Ne ions for deep tumor therapy were examined, and some studies with neutrons and mesons were described. (BBB)

15052 IN VITRO ASSAY OF THE EFFECT ON BONE MARROW CELL PROLIFERATION OF FACTORS IN SERUM FROM THE IRRADIATED RAT. Cederberg, A.; Niskanen, E.; Rytomaa, T. (Univ. of Helsinki). Acta Physiol. Scand., 70: 147-57 (June 1967).

An attempt was made to demonstrate the existence or nonexistence in rat serum of humoral factors responsible for the true regeneration process in bone marrow cells after irradiation. The effects of the test serum, collected at the time of onset of true regeneration (10 days after whole-body irradiation with 600 R), were assayed in vitro, using normal bone marrow cells as target tissue. The results demonstrated that, on the average, the proportion of ^{3}H-thymidine-labeled cells was about 24% higher in cultures incubated in the presence of test sera than control sera. On the basis of partial differential counts (percent mature granulocytes), and measurements of total ^{3}H radioactivities incorporated in the whole population of cells (both estimations being performed on some of the preparations also analyzed by autoradiography), it

was concluded that the effect of serum from whole-body irradiated rats was due to one or more factors which stimulate resting progenitor cells to enter the generative cycle. (BBB)

15053 THE CONTROL OF THE COURSE OF HEALING OF X-IRRADIATED BRONCHIAL CARCINOMA BY BRONCHOGRAPHY. Gilly, G.; Vogelgesang, K. H. (Knappschafts-Krankenhaus, Recklingshansen, Ger.). Roentgen Bl., 19: 557-62(Nov. 1966). (In German).

Regression of primary bronchial tumors could be produced by x irradiation with a focal dosage of 5000 R administered by pendulum convergence technique, using a voltage of 200 KV, as demonstrated by bronchographic study. The daily dose amounted to 200 R. Irradiation fibrosis could result to some extent. Administration of a second irradiation series could be determined by bronchographic follow-up examinations. The bronchial deformations that followed the irradiation could not be entirely related to it, and extension of previously atelectatic pulmonary areas did not always occur. To ascertain the efficacy of the irradiation treatment, follow-up outpatient control by bronchography is advisable. If a second irradiation series was required, a focal dose of 3000 R should be administered. (BBB)

Radiation Effects on Animals

Refer also to abstracts 14905, 14906, 14910, 14920, 14930, 14956, 14958, 14966, 14969, 14971, 14975, 14979, 14982, 14986, 14987, 14994, 15002, 15015, 15020, 15033, 15035, 15036, 15038, 15042, 15043, and 15049.

15054 SOME COMPARATIVE ASPECTS OF THE RECOVERY OF CELLS DAMAGED BY IONIZING RADIATION. Korogodin, V. I. (Inst. of Medical Radiology, Moscow). Radiobiologiya, 7: 728-43(1967). (In Russian).

The various manifestations of postirradiation recovery of cells are compared, the mechanisms of viability recovery by irradiated cells are discussed, the target theory is criticized, and two directions are proposed for solving the problem of the role of repair processes in recovery of cells from radiation injuries. (TSS)

15055 THIRTY-YEAR SURGICAL EXPERIENCE WITH THYROID CANCER. McGovern, J. Bruce; Mannix, Henry Jr. (Cornell Univ., New York). N. Y. State J. Med., 67: 2207-14 (Aug. 15, 1967).

Incidence of radioinduced thyroid cancer was evaluated in a survey of the authors' cases and those reported in the literature. The two to one female to male sex ratio was in accordance with most published series on thyroid cancer. A classification by age into decades indicated that this disease attacks a younger group of patients than do most other carcinomas. Many of the patients had noted a neck mass for a considerable period of time, in seven cases over 30 yr. A history of radiation to the head and neck during infancy and childhood was found in 2% of cases. This low figure is a reflection of the adult population of this series. Other series limited to carcinoma in children showed a 50 to 80% incidence of prior radiation therapy, an average of 8.7 yr prior to hospital admission. There is no reported relation between irradiation of the neck in adults and the subsequent development of thyroid cancer. In 54.5% of the cases, the patients were seen with the classical thyroid nodule; however, 17.2% of the carcinomatous glands were multinodular. Radioiodine scintiscanning was confirmatory in 10 of the 12 cases where it was applied. Thyroid carcinoma was associated with a variety of other diseases of the gland, especially myxedema, nontoxic nodular goiter, and thyroiditis. (BBB)

15056 AN INVESTIGATION BY HOIGNE'S METHOD OF AUTOSENSITIZATION IN GUINEA PIGS DAMAGED BY ^{210}Po. Ulanova, A. M. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 553-5(1967). (In Russian).

Hoigne's reaction, as modified by Klemparskaya, permitted determination of the presence of autosensitization processes in guinea pigs damaged by ^{210}Po from the first days to two years after injury. Most of the positive cases were noted on the third day. The reaction is highly sensitive and reveals changes not causing clinical manifestations of radiation sickness. (JPRS)

15057 DEPENDENCE OF HEMOPOIESIS RECOVERY RATE ON THE EFFECTIVE RADIATION DOSE. Gorlov, V. G. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 576-8(1967). (In Russian).

Mature male rats (150) weighing 180 to 220 g were irradiated at 196 to 192 R/min in doses of 300 and 600 R. Observations were made of the change in the number of erythrocytes and leukocytes in the peripheral blood, the mitotic index, the number of aberrant mytoses in marrow cells and the total number of nuclear marrow cells passing into the femur. The observations were made 1, 3, 7, 14, and 21 days after irradiation. The rate of recovery of hemopoiesis was determined by the slope of curves of the investigated indices from the time of their maximum decrease to 21 days after irradiation and was correlated with the effective dose, which can serve as a measure for quantitative evaluation of postirradiation recovery of both the entire organism and its individual functions. (JPRS)

15058 REASONS FOR DISAGREEMENTS IN EVALUATING CENTRAL NERVOUS SYSTEM RADIOSENSITIVITY BETWEEN INVESTIGATORS USING CONDITIONED-REFLEX AND LABYRINTH METHODS. Livshits, N. N. (Inst. of Biological Physics, Moscow). Radiobiologiya, 7: 790-800(1967). (In Russian).

The literature on the determination of radiosensitivity in rats by conditioned-reflex and labyrinth methods is surveyed. The differences are explained by peculiarities of the methods and not by errors in the investigations. Disturbance of labyrinth activity is more readily compensated than that of conditioned-reflex activity because, in a labyrinth, an animal can use information arriving simultaneously through various afferent systems and there are many afferent organs for response reaction. This is of great importance in radiation pathology, where focal disturbances of neuron functions are diffuse. Comparison of the results obtained by the two methods reveals the functions of higher sections of the CNS most damaged by radiation as well as possibilities for compensation. There is much experimental material which contradicts the opinion of some investigators that a change in the latent period and magnitude of a conditioned reflex expresses only or mainly the change of excitability of the conditioned-reflex centers. (JPRS)

15059 EFFECT OF IONIZING RADIATION ON THE CENTER OF AUTOMATISM OF FROG HEART. Hajnal-Papp, M.; Niedetzky, A. (Medical Univ., Pecs, Hungary). Acta Biochim. Biophys. (Budapest), 2: 199-204(1967).

Spontaneous contractility of sinus fragments of frog heart stopped in K-free solution, and was reestablished in some sinus fragments in K-free solution containing radiosodium (^{24}Na). Out of 77 sinus fragments placed in radioactive solution 31 (40%) regained activity, but of the 77 sinus pieces placed in inactive solution none started again. Radiosodium solutions of different activities were used (4 to 160 μCi/ml). The periods of time elapsing until the reestablishment of contraction differed widely. The average value was 18 ± 13 min. No correlation was found between the period of time elapsed and the activity of the solution. The value of the correlation coefficient was +0.3. The effective dose was calculated on the basis of the radioactivity of the solutions and the period of time elapsing until the restarting of contractions. The effective dose varied over a wide range (1 to 130 rad). No correlation was found between the dose and the rate of restarting within these dose limits. Thus the effect was independent of the dose. The data showed also that the isolated sinus was more sensitive to K deficiency than the whole heart. The contraction of the sinus fragments placed in K-free solution stopped within an hour, but isolated hearts kept in K-free solution only after one to four days. (BBB)

15060 CLEARANCE OF 4-IODOANTIPYRINE-^{125}I AFTER SUBCUTANEOUS INJECTION IN VARIOUS REGIONS. Munck, O.; Andersen, A. M.; Binder, C. (Glostrup Hospital, Copenhagen). Scand. J. Clin. Lab. Invest., 19: Suppl. 99, 39-45(1967).

The radiation exposure of the thyroid gland was determined in the course of studies on the circulation of the skin in various regions based on the local clearance of the relatively fat soluble 4-iodoantipyrine-^{125}I after subcutaneous injection. Its radiochemical purity was examined by paper chromatography using the eluent n-butanol-acetic acid-water (120 : 30 : 50 v/v). The amount of ^{125}I present as iodide varied from 2 to 5%. Iodine-125 is a soft γ-ray emitter (35 keV) with a half-life time of 60 days. On the assumptions that 1 μCi was injected for each measurement, that about half of the radioactivity was located within a sphere with a radius of 1 cm, that the biological half-life time in the deposit was 10 min, that the half-time of antipyrine in the organism was 12 hr, that 2% of ^{125}I was present as iodide, that the half-time of iodide from the thyroid gland was 60 days, and that the weight of the thyroid gland was 20 g, then the dose for the skin deposit would be 6 mrem, the dose for the thyroid gland 40 mrem, and the whole-body dose negligible. (BBB)

15061 INFLUENCE OF UV RADIATION ON THE POST-EMBRYONAL DEVELOPMENT OF THE TESTES OF THE WHITE MOUSE (MUS MUSCULUS L.). Surowiak, Jozef (Jagellonian Univ., Krakow). Vestn. Cesk. Spolecnosti Zool., 29: 255-81(Aug. 1965).

Male mice were irradiated, from the second or third day of life, with uv rays in a wavelength range of 289 to 405 nm and from 254 to 405 nm. Histological and histochemical examination of tissue sections demonstrated two trends in the development of the gonads

after irradiation. In mice irradiated in the spectral range of 289 to 405 nm from 1.5 to 10 min daily from the third day of life to the eighth week, with a dose of about 23,000 erg/sec-cm^2, or for 15 min daily from the second day of life with a dose of 36,200 erg/sec-cm^2, an acceleration was seen in the rate of development of the gonads, with intensified spermato- and spermiogenesis processes, in comparison with normally developing testis. In another experimental group of animals irradiated with a wavelength range from 254 to 405 nm 15 min daily starting from 1 min on the second day of life with about 55,000 erg/sec-cm^2, involutional changes were seen in the epithelium of seminiferous tubules, that caused an inhibition of spermatogenesis and retarded sexual maturity of individuals. These changes were identical in their final effects with those caused by ionizing radiation. The dose of uv radiation and not its spectral range was decisive in the kind of influence this radiation had upon the organism. (BBB)

15062 RADIATION STUDIES ON MICE OF AN INBRED TUMOR-RESISTANT STRAIN. V. POSSIBLE EVIDENCE FOR ACTIVATION OF THE MAMMARY TUMOR VIRUS (MTV) BY URETHANE AS OBSERVED BY ELECTRON MICROSCOPY. Goldfeder, Anna; Ghosh, Ajit Kumar (New York Univ., N. Y.). Tex. Rep. Biol. Med., 25: 396-409(Fall 1967).

Studies were made on the carcinogenic effects of urethane alone and in combination with x irradiation on mice of a tumor-resistant strain, designated X/Gf. No malignant neoplasms, either in solid form or as leukemias, appeared in these mice spontaneously or after whole-body x irradiation. Since ionizing radiation has proved to be a potential carcinogenic agent in mice of other strains, as well as in different animal species, the negative response of the X/Gf mice was unusual. Consequently, it was of interest to test the response of X/Gf mice to chemical agents alone and in combination with x irradiation. Mammary tumors appeared in 4.4% among females over one year of age after treatment with urethane alone and in 3.1% among those treated in combination with x irradiation (300 to 400 R, whole-body). Thus x rays exert no potentiating effect on urethane carcinogenesis in X/Gf mice. Additional experiments were performed in order to obtain more information on this problem. Virus particles were noted in a mammary lesion of a urethane-treated X/Gf female mouse. This mouse received four weekly urethane injections of 0.75 mg/g body weight (a total of 45 mg at the age of three months). The tumor appeared 11 months after the treatment when the mouse was 15 months of age. Electron microscopic studies of the tumor revealed characteristic virus particles like those known as the Bittner virus or "milk agent." Since the females of the X/Gf strain usually do not produce mammary tumors spontaneously, it was suggested that urethane could have activated a latent virus which was incidentally present in the mammary glands of this individual mouse. (BBB)

15063 CHANGES IN LENS EPITHELIUM AFTER X-RAY OR NEUTRON IRRADIATION (MOUSE AND RABBIT). Richards, Richard D. (Univ. of Maryland, Baltimore). Trans. Amer. Ophthalmol. Soc., 64: 700-34(1966).

In addition to clinical observations and histological sections of lenses, flat mount preparations of the entire lens epithelium were used to study cataracts in the mouse and rabbit induced by 250-KV x rays and fast neutrons. A sharp depression of mitotic activity followed by a rise to levels above the normal range was observed in mouse lens epithelia exposed to single or multiple doses of neutron or x radiation. Mitotic activity returned to normal levels about one month postirradiation. A decreased mitotic activity beginning at about two to three months after irradiation was correlated with the complete opacification of lenses. Although mitotic activity was completely suppressed by a single dose of 400 rad of x radiation, mitotic activity was not completely suppressed by the second of two fractionated doses of 450 rad each. Some mitotic activity was also observed after two fractionated doses of 400 rad each and after three doses of 300 rad each. Anterior plaques were characteristic of irradiated mouse lenses. These were not formed in the same way as posterior plaques. The mitotic activity in rabbit lenses after partial shielding during x irradiation was modified in proportion to the area shielded. X-radiation injury was localized to the exposed area, and no evidence of cell migration from shielded to exposed area was observed. The pattern of x-ray injury suggested that diffusion of substances from the shielded to exposed area was the manner in which modification of damage was achieved. The pattern of recovery after sector irradiation of ¼ or ½ the lens suggested selective migration of normal or minimally damaged cells from the germinative area into the lens bow area and retention of cells showing greater damage in the germinative zone. The critical area to be shielded to significantly modify x-ray injury was ~¼ the lens area, and there was no significant difference between shielding the periphery or central portion of the lens. (BBB)

15064 ACUTE RADIATION SYNDROME. Beck, E. Schweiz. Med. Wochensch., 97: 1155-6(Sept. 2, 1967). (In German).

Brief, intensive irradiation of humans resulted in injuries to the blood-forming organs and the gastrointestinal tract that predominantly determined the prognosis of the radiation syndrome. Although the bone marrow aplasia produced by irradiation was clinically significant, survival was still possible even with heavy damage, but irreversible damage of the intestinal epithelium produced death within the first two weeks after irradiation exposure. Damage to the blood-forming organs was proportional to the total irradiation dose absorbed. The granulocytes and their precursors, the megakaryocytes, and immature erythrocytes were less radiosensitive than the lymphatic elements. With medium doses increased granulocyte and thrombocyte values were observed. At doses of 25 to 50 rad the lymphocyte values were unaffected, at 50 to 100 rad lymphocytes decreased by 50%, at doses over 100 rad the lymphocytes decreased to 10 to 50% of normal, and at doses over 200 rad bone marrow mitoses disappeared within four days of irradiation and marked granulocytopenia appeared within three to five weeks. After a dose greater than 400 rad severe pancytopenia could be expected within 10 or 20 days. Shortly after high doses of irradiation, nausea, vomiting, shock, and spastic abdominal cramps were observed. After this initial phase a period of well being was observed for periods of a few hr to several weeks. In the third critical phase after a dose in the range of 800 to 2000 rad, gastrointestinal symptoms of injury were more evident than hematological symptoms, while after doses of 200 to 500 rad the clinical severity was determined by the granulocytopenia that developed in the third to sixth week. Resistance to bacterial infections was markedly decreased, and antibiotics were relatively ineffective. Hemorrhagic symptoms could be controlled by transfusions of blood or thrombocytes, but the granulocytopenia was difficult to treat. Immune reactions could reduce the efficacy of bone marrow transplantation, except where marrow destruction was complete. Treatment of all irradiated persons required close attention to microbial decontamination, avoidance of exposure, all measures of radioprotection, and excellent treatment facilities. (BBB)

15065 ACTIVATION ANALYSIS. Alexander, W. D. (Western Infirmary, Glasgow); Harden, R. McG.; Boddy, K. Brit. Med. J., 1: 799(Sept. 23, 1967).

Brief discussion is offered on a previous report (ibid., 2: 509 (Aug. 26, 1967)) that uniform irradiation of the thyroid gland is not possible with neutrons. It was pointed out that this was true only for irradiation by thermal neutrons as used in the technique for which it was necessary to use an internal standard of ^{129}I. In the present authors' measurements in man it was shown that by deliberately filtering out the thermal neutrons and using only neutrons of higher energies (epithermal and fast neutrons) not only was the irradiation adequately uniform but also the iodine in the gland was activated preferentially, compared with Na and Cl, because of the behavior of the neutron capture cross-sections of these elements as a function of neutron energy. Studies with thyroid phantoms of various sizes confirmed that uniformity of thyroid irradiation using epithermal and fast neutrons was to be expected. Good agreement was obtained between in vivo activation measurements, and subsequent in vitro activation and chemical measurements of iodine in the same gland. It was shown that the in vivo measurement of total intrathyroidal iodine in man could be made with radiation doses to the thyroid not exceeding those of an uptake test using 12 μCi of ^{131}I. (BBB)

15066 INVESTIGATIONS OF THE REACTIONS TO LIGHT IN PSORIASIS PATIENTS. Szabo, Eva; Horkay, Irene (Univ. Skin Clinic, Debrecen, Hungary). Z. Haut- Geschlechtskr., 39: 425-9(1965). (In German).

Psoriatic patients were irradiated in a limited area over the gluteus muscle with uv of 3600 Å from a distance of ½ m at a room temperature of 25°C. The erythema maximum produced was measured as the number of sec of irradiation required to produce erythema. In the eruptive psoriatics the average erythema dose was 50 sec, and in patients with discoid psoriasis the average erythema dose was 2 min 10 sec. In some of the latter patients erythema doses as high as 8 to 10 min were observed. Only one of these patients had a erythema dose less than 1 min. Similar differences were observed in patients under treatment with keratolytic drugs or sedative drugs. The increased sensitivity of the patients with eruptive psoriasis to uv irradiation could have been due to vascular changes or lesions. It was likely that it was unrelated to skin pigmentation. The uv irradiation could have triggered some basic neurovascular reflex mechanism, or could have acted as a stimulus to the primary capillaries and affected their function. (BBB)

15067 EFFECT OF LASER RADIATION ON RETINAL VASCULAR ANOMALIES. L'Esperance, Francis A. Jr. (Presbyterian Medical Center, New York). Int. Ophthalmol. Clin., 6: 351-8(Summer 1966).

The histological findings after laser irradiation of the retinal vessels of animal eyes are reported. There was a significant difference in the response of monkey eyes and of rabbit eyes to laser irradiation. Despite intensive laser bombardments, the retinal blood vessels of rabbits appeared unaffected. Although arteriolar spasm was observed repeatedly during the treatments, histological evidence of permanent vascular damage could not be demonstrated, probably due to the lack of pigment and poor absorption of the white medullated nerve fiber layer upon which the retinal vessels rest. Histological examination of the monkey eyes showed definite changes in the retina and choroid after one to three treatments. They consisted of destruction of the outer nuclear and rod-cone layers, moderate proliferation of the pigment epithelium and choroid pigment, and occasional areas of obliteration of the choriocapillaries. Intravascular thrombosis, clotting, coagulum, or precipitates were not observed. Vascular changes became more apparent in the monkey eyes when exposed to laser radiation during four or five treatment sessions. These changes consisted of intraretinal pigment migration and proliferation, a decrease in the mural cell population, and an increase in the irregularity of the vessel wall with some disruption of the normal architecture. In monkey eyes subjected to six to eight treatments, a latticework of melanocytes extended from the pigment epithelium to the perivascular area of the retinal vessel. Pigment cells had infiltrated into the adventitia of the irradiated vessel and had displaced the mural cells. The entire retina in these areas appeared thinner and more firmly adherent to the choroid. (BBB)

15068 EFFECT OF γ RADIATION ON ISOLATED FROG HEARTS STOPPED AS A RESULT OF Ca DEFICIENCY. Niedetzky, A. (Medical Univ., Pecs, Hungary). Acta Biochim. Biophys. (Budapest), 2: 205-10(1967).

Contractile activity of the isolated frog heart was reversibly inhibited in Ca-free solution. Potassium content of the heart significantly decreased and Na content increased. Such hearts could not be stimulated either by mechanical or by electrical stimuli. Upon γ irradiation with ^{60}Co, contraction of some hearts was reestablished. The effective dose was found to be ~190 rad. Even in long-term experiments no deleterious effect of this dose on the mechanical activity of the hearts was observed. The value of the dose necessary to restart heart activity was almost the same whether the hearts had been arrested in a K-free or a Ca-free solution. This dose was two orders of magnitude higher than the dose having a restarting effect with radioactive solutions (^{24}Na). The dose rate was 135 rad/hr at the site of irradiation. Different time periods elapsed until the hearts started beating but the fluctuation was comparatively small (1.4 ± 0.4 hr). When hearts arrested in a Ca-free solution were irradiated with visible light, no restoration of activity was observed. (BBB)

15069 INTERFERENCE BY NEAR ULTRAVIOLET AND GREEN LIGHT WITH GROWTH OF ANIMAL AND PLANT CELL CULTURES. Klein, Richard M. (Univ. of Vermont, Burlington); Edsall, Pamela C. Photochem. Photobiol., 6: 841-50(Nov. 1967).

The deleterious effects of near uv and other wavelengths emitted by fluorescent lamps on plant and animal cells are reviewed, and some new studies reported. The deleterious wavelengths in fluorescent light were in the near uv at or near 365 nm, and in the green-yellow range at 546 nm and/or 579 nm. These wavelengths were Hg excitation lines emitted by most fluorescent lamps. The near-uv and green-yellow (546 to 579 nm) radiations were shown to repress growth in liquid cell cultures of Ginkgo pollen and of monolayer cultures of HeLa cells. The deleterious effects of green-yellow wavelengths could be negated by red radiation; near-uv-induced growth repressions were insensitive to visible light photorestoration. These wavelengths did not interact synergistically and evoked different kinetics of response. (BBB)

15070 DAMAGE ACCUMULATION AND RECOVERY IN THE FISH ORYZIAS LATIPES EXPOSED TO FRACTIONATED OR PROTRACTED RADIATION AT DIFFERENT TEMPERATURES. Etoh, Hisami; Egami, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). Radiat. Res., 32: 884-91(1967).

In the fish, Oryzias latipes, 3 to 4 kR of x irradiation was less lethal if applied in several separate fractions at intervals than if applied in the same total dose given by a single acute exposure. The effect of the dose fractionation was clearer if the total time from the first irradiation to the last one was longer. In this respect the number of fractions appeared to be of no consequence. Decrease in lethal effect by dose fractionation did not take place if temperature during the interval period was low. A similar dose-fractionation effect was recognized in acute γ irradiation. Furthermore, in chronic irradiation with a given total dose of γ rays, the shorter the duration of exposure, the stronger was the noxious effect. However, if temperature during the irradiation was low, the dose-rate effect was not observed. The present results seem to support the assumption that recovery from radiation-induced damage proceeds to some extent during the interval between the fractions in acute irradiation, or during radiation-on time in chronic irradiation, and that the rate of the recovery is slowed down under low-temperature conditions. (auth)

15071 LIGHT TESTS AND PATHOGENETIC WAVELENGTHS IN CHRONIC POLYMORPHOUS LIGHT DERMATOSIS. Verhagen, A. R. H. B. (Binnengasthuis, Amsterdam). Dermatologia, 133: 302-12(1966).

In 92 patients the uv wavelengths causing chronic polymorphous light dermatosis (CPLD) were investigated. A high-pressure mercury arc and a xenon arc were used. The xenon lamp emitted a continuous spectrum; however, the distribution of radiation energy over the spectrum was not completely identical to natural sunlight. In comparison to terrestrial sunlight, the xenon arc emitted more energy in the short wave sunburn spectrum (290 to 315 mμ) and its spectrum included uv wavelengths between 260 and 290 mμ, that are not present in terrestrial sunlight. The minimal erythema dose was determined through exposing the dorsal skin. This dose and sensitivity to long wavelength uv tests provided good evidence in most cases for CPLD, but in one-quarter of the cases there was no indication of abnormal sensitivity after single irradiation and more elaborate tests were required. Correlation between the degree of experimentally found sensitivity to uv light and the clinical type and the course of the disease is discussed. It was concluded that the pathogenetic action spectrum is not identical in different patients, but about one-third of the cases are definitely sensitive to long wavelength uv light (315 to 360 mμ) and about one-half react to the lower wavelengths (<315 mμ). (BBB)

15072 MAJOR CONGENITAL MALFORMATIONS FROM IRRADIATIONS OF SPERM AND EGGS. Newcombe, Howard B.; McGregor, John F. (Chalk River Nuclear Labs., Ont.). Mutat. Res., 4: 663-73(Sept.-Oct. 1967).

Major malformations of the embryos of rainbow trout (Salmo gairdneri) were substantially more frequent following exposure of the sperm or eggs to ionizing radiation. The response per unit dose fell off at high doses but at 200 rads, the lowest dose used, there was a yield of ~300 malformations per 10^6 embryos per rad, for irradiation of either kind of gamete. Assuming that the response varied linearly with dose at still lower levels, ~26 rads would be required to double the rate observed in the controls. Reasons for believing that the major malformations may be associated predominantly with gross chromosomal changes, such as those due to non-disjunction, are discussed. The advantages of this organism for studies of the dose-response relationships down to low doses, the current lack of such information, and its possible bearing on both a theoretical problem and the practical task of assessing radiation risks in man, are noted. (auth)

15073 THE RADIOSENSITIVITY OF OFFSPRING OF AN IRRADIATED MOUSE POPULATION. I. EFFECTS ON THE REPRODUCTIVE CAPACITY OF IRRADIATED FEMALE OFFSPRING. Sheridan, William (Lab. of Radiation Genetics, Stockholm). Mutat. Res., 4: 675-81(Sept.-Oct. 1967).

Female offspring to the 13th generation of a population in which the males have been irradiated with 276 R X rays to the spermatogonia in each generation, and offspring from the corresponding control population were irradiated with doses of 65 R or 100 R and their production studied. No significant differences between the groups at either dose level were found in numbers of litters or in litter size. An increase in length of the gestation period was noted in all groups. The feasibility of using reproductive capacity as an alternative to mortality in determining differences in radiosensitivity is considered. It is concluded that offspring to unirradiated groups do not stand a lesser risk from irradiation than offspring to previously irradiated groups. (auth)

15074 THE RADIOSENSITIVITY OF OFFSPRING OF AN IRRADIATED MOUSE POPULATION. II. THE EFFECTS OF ACUTE OR FRACTIONATED DOSES OF X RAYS ON MALE OFFSPRING. Sheridan, William; Ronnback, C. (Lab. of Radiation Genetics, Stockholm. Research Inst. of National Defence, Sundbyberg, Sweden). Mutat. Res., 4: 683-8(Sept.-Oct. 1967).

The LD_{50} value for male offspring of a mouse population in which the sires of each generation have received 276 R x irradiation to the spermatogonia was determined. The LD_{50} values for the corresponding control population's offspring, and the CBA strain from which the populations derive, were also determined. Offspring of the three groups were also submitted to fractional doses of x rays totalling 1400 R, and the survival time observed. No differences in LD_{50}, or survival after fractionated exposures, were observed between the irradiated population offspring and offspring of the control. The CBA strain mice showed a greater radiosensitivity than either population in all experiments. It was concluded that ances-

tral irradiation did not necessarily lead to a decrement which will be manifested as a difference in response to irradiation. (auth)

15075 FUNDOSCOPIC AND HISTOPATHOLOGIC CHANGES FOLLOWING EXPERIMENTAL COAGULATION BY VARIOUS METHODS. McPherson, Alice; Girard, L. J.; Hall, M. (Baylor Univ. Coll. of Medicine, Houston, Tex.). Mod. Probl. Ophthalmol., 5: 398-413(1967).

Effects of laser irradiation on the eye of dogs were examined and compared with those produced by other light sources. At 24 hr after laser irradiation ophthalmoscopic examination showed a small, circular lesion composed of a central accumulation of pigment surrounded by a pigmented band, surrounded by a halo due to retinal edema. In some lesions, hemorrhage was visible. Upon microscopic examination of the lesion at 24 hr, exudation was seen both subretinally and intraretinally. There was loss of retinal substance, and all layers of the retina were distorted, particularly in the central part of the lesion. At three days, ophthalmoscopically, an increase in pigmentation was noted. Microscopically, there was greater distortion and destruction of the retinal layers, as well as increased subretinal exudation, that filled the defect caused by the loss of retinal substance in the central part of the lesion. At one week, edema had subsided markedly, but a pigmented dot remained at the center of the lesion. Histologic examination showed necrosis of all retinal layers and their replacement by glial proliferation. After three weeks, no edema was seen ophthalmoscopically, and microscopic study showed a firm chorioretinal adhesion, resulting from metaplastic changes in the pigment epithelium. (BBB)

15076 THE EFFECTS OF UNILATERAL RENAL IRRADIATION ON THE HIPPURAN-^{131}I RENOGRAM IN RABBITS. Caldwell, W. L. (Vanderbilt Univ., Nashville); Bosch, A.; Thomassen, R. W.; Irizarry, S. J. Urol., 98: 154-8(Aug. 1967).

Effects of renal irradiation on the hippuran-^{131}I renogram pattern were studied to provide information regarding physiological responses to such irradiation. Preliminary tests showed a paradoxical abnormality: a delayed third segment of renograms of the nonirradiated right kidney of rabbits with an irradiated left kidney. This effect was most pronounced and prevalent during the first few weeks after irradiation. It was not noted in animals with bilateral renal irradiation, whether the whole of both kidneys or only half of each kidney was irradiated. Data were accumulated in an effort to further document and explain this phenomenon. Renograms, after injection of 12 μCi of hippuran-^{131}I, were obtained on each rabbit before irradiation. The left kidney of each animal then received 2200 RAD in a single acute exposure lasting 19 min and 8 sec with ^{60}Co γ rays through a 6 by 5 cm dorsal field. At four day intervals the renograms were repeated and some animals sacrificed every four days for histological evaluation. A paradoxical delay in the excretory segment of the nonirradiated right kidney was confirmed. It occurred in ~18% of the right renal tracings and in only 7% of the left tracings. The reason for the frequency delay in the third segment, particularly in the non-irradiated kidney, was not obvious. An obstructing lesion of the ureter or profound tubular distension with associated urine retention could also account for it. An autoimmune reaction secondary to renal damage from irradiation might play a role. (BBB)

15077 HEART DISEASE FOLLOWING RADIATION. Cohn, Keith E.; Stewart, J. Robert; Fajardo, Luis F.; Hancock, E. William (Stanford Univ., Palo Alto, Calif.). Medicine, 46: 281-98(May 1967).

Incidence of radioinduced heart disease, the spectrum of clinical features seen in this disease, their natural course, results of treatment, and doses and technics of radiation used are considered on the basis of a series of 21 patients who were seen with pericardial or cardiac disease following treatment of malignant neoplasms with radiotherapy. It is proposed that radioinduced cardiac damage, particularly acute and chronic pericarditis, is more frequent and significant than is generally recognized. Eleven patients had received radiotherapy for Hodgkin's disease, five for carcinoma of the breast, and one each for malignant thymoma, metastatic carcinoma of the cervix, round cell tumor of the rib, carcinoma of the esophagus, and reticulum cell sarcoma. Before radiotherapy, pre-existing heart disease was not detected in any of the patients. Seventeen of the 21 patients received x-ray therapy by linear accelerators operating at peak energies of 5 to 6 MeV. Lead blocks were used to protect the lungs, spinal cord, and apex of the heart if this appeared possible without risk of shielding tumors. The usual dose by this method was 4000 rad to the midplane in four weeks. Patients treated following radical mastectomy for breast carcinoma received a depth dose of 5500 to 6075 rad in five weeks. Dose distribution considerations indicated that a portion of the heart received in excess of 3000 rad when the tumor dose was 5500 rad. The radiation was fractionated in all 21 patients, so that weekly doses of 500 to 1250 rad were delivered in four or five daily sessions. Low QRS voltage, T-wave flattening and inversion, and ST segment elevation were commonly seen in the electrocardiogram. Eleven patients demonstrated various forms of chronic pericardial disease classified as: uncomplicated chronic pericardial effusion; chronic constructive pericarditis with varying degrees of active inflammation and chronic pericardial effusion; and chronic constructive pericarditis with myocardial and endocardial fibrosis without pericardial effusion. At autopsy the parietal and visceral layers of the pericardium were markedly thickened due to dense deposition of collagen, with numerous capillaries among the collagen fibers, and the arteries and veins sometimes showing intimal proliferation. Disease of the major coronary arteries was absent. Bizarre, large, irregular fibroblasts were present in one instance. Fibrinous exudate was frequently present on the pericardial surface. Calcification was not seen. Two individuals showed other forms of heart disease that appeared attributable to radiation. One developed signs of mitral insufficiency and left bundle-branch block 11 yr after radiotherapy for a round-cell tumor of the ribs of the left thorax. The estimated dose of radiation to the heart was 4700 rad in 50 days. A 15-yr-old boy suffered a fatal acute myocardial infarction 16 months after receiving 4000 rad for Hodgkin's disease. Postmortem examination showed severe intimal proliferation and atheromatous deposits in all of the major coronary arteries, thrombosis of the anterior descending branch, and a large acute anteroseptal myocardial infarction. (BBB)

15078 EARLY BLOOD REACTIONS TO THE EFFECT OF X-RAYS AND PROTONS. Petrovich, I. K.; Moskalev, Yu. I. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 530-6(1967). (In Russian).

White rats weighing 150-200 g were x-irradiated at doses of 10, 50, 100, 200, 400, 1000, 2000, 4000, 8000, and 12,000 R and protons at doses of 50, 200, 700, and 1000 R. The composition of the peripheral blood was investigated before and after irradiation. The lymphocytes were destroyed and disappeared from the peripheral blood in 6-8 hrs and at large doses over 70% of them were destroyed in 15-30 minutes. The neutrophils were destroyed in 10-12 hrs, and 50% of the erythrocytes in 14 days. In the first days the main processes were redistribution of mature blood cells, their mobilization from the marrow (reticulocytes and thrombocytes), and acceleration of maturation and destruction. The first signs of recovery appeared in the leukocytes after 3-5 days and in the erythrocytes after 14 days, but all animals receiving doses of 800-1000 R or more died. (JPRS)

15079 DEPENDENCE OF CELL RADIATION INJURY ON THE IONIC STRENGTH IN THE MEDIUM. Polivoda, V. I. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 498-503(1967). (In Russian).

A three-day culture of heart cells of a normal monkey cultivated in synthetic medium 199 was placed in solutions of different ionic strengths, irradiated, treated with versene and placed in nigrosin. The suspension was kept at 37° and the living and dead cells were counted after 1.5 to 2 hours and then every 30 minutes for five hours. It was found that the injury of cells irradiated at 5000 R depended on the concentration of K^+ ions in the solution at the time of irradiation but not on the concentration of glucose or Na^+, Cl^- or SO_4^{--} ions. The minimum lethality (15-20%) was at a concentration of 50 to 100 mmoles of K^+, and the maximum (95-60%) was at normal and near normal concentrations and also at concentrations above 100 mmoles. (JPRS)

15080 INFLUENCE OF SOFT X-IRRADIATION ON THE ENDURANCE OF ANIMALS UNDER PHYSICAL LOADS. Liberman, A. N.; Sakovskaya, M. S. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya, 7: 625-7(1967). (In Russian).

Forty-four female mice weighing 18 to 22 g were used in four groups of 10, 12, 11, and 11. The first group received 1530 R of soft x rays at 41.8 R/min, the second and third 350 and 260 R of hard x rays respectively at 23.4 R/min, and the fourth group was a control. Studies showed a reduction of the endurance of animals in the first two groups of 10-21% under physical load on the 14th, 21st, and 29th days after irradiation. The third group displayed no significant changes in endurance. A 1530 R dose of soft x rays had an effect on endurance corresponding to 350 R of hard x rays. (JPRS)

15081 CHANGE IN THE ELECTRORETINOGRAM DURING IRRADIATION. Trunova, N. M. (Inst. of Medical and Biological Problems, Moscow). Radiobiologiya, 7: 548-52(1967). (In Russian).

Rana ridibunda and Rana temporaria frogs were irradiated at 0.1, 2, 30, 60, and 90 R/sec. Test electroretinograms were taken during gamma radiation for 40-70 minutes with indications of the dose rates. It was found that the change of the luminous ERG with radiation depends on the dose rate. At 0.1-2 R/sec of gamma

radiation, an increase of the electrical activity on the radiation background was the most typical process. A dose rate of 30–90 R/sec depressed the test ERG to the point where the generation of bio-electric potentials ceased. (JPRS)

15082 PATHOGENESIS OF RADIATION-INDUCED ENDOCRINE TUMORS. Berdjis, C. C. (Experimental Medicine Dept., Edgewood Arsenal, Md.). Oncology, 20: 49-60(1967).

It appears that atrophy, cellular degeneration and/or degradation together with increased PAS-positive material and precocious senescence creates an abnormal situation that engenders bizarre or preneoplastic cells. In all probability these cells are responsible for neoplastic proliferation and production of endocrine tumors. It was shown that irradiation has a predilection for endocrine organs, and the radiation-induced genetic factors can influence the induction of endocrine tumors. This predilection is of greatest interest in correlating the mutagenic theory of cancer and endocrine imbalance. Hypogonadism and impairment of physiological function was suggested to induce pituitary disorder and/or adenoma that, by release of pituitary tropic hormones, produces endocrine adenomatosis. (auth)

15083 RADIATION PROTECTION BY X RAYS. A RADIOBIOLOGICAL PARADOX. Krokowski, E.; Taenzer, V. (Freie Univ., Berlin). Deut. Med. Wochenschr., 92: 737-42(Apr. 21, 1967). (In German).

Studies in rats were described that appeared to indicate that whole-body irradiation with 300 R, given two weeks previous to an LD_{50} dose of 925 R, increased the survival of the animals. It also seemed to protect the animals against a dose of 1850 R, twice the LD_{50} dose. The radiogenic protective effect was independent of the level of the preirradiation dose. The effect was observed only when the interval between the preirradiation amounted to 14 days or more. The interval could be extended up to 200 days and the effect still be observed. The authors concluded that probably the radiogenic protective effect observed could be related to the formation of antibodies that were specific for the denaturation products derived from body proteins by irradiation. (BBB)

15084 SURGICALLY TREATED THYROID DISEASE AMONG YOUNG PEOPLE IN UTAH, 1948–1962. Weiss, Edward S. (Public Health Service, Rockville, Md.); Olsen, Richard E.; Thompson, Carlyle; Masi, Alfonse T. Amer. J. Public Health, 57: 1807-14(Oct. 1967).

A preliminary report on the frequency of thyroid surgery and particularly thyroid cancer among young people in Utah from 1948 through 1962 apparently indicates an increase, primarily in the 20 to 29 yr age group. Reasons for examination of the possibility of thyroid injury to Utah infants and young children as a consequence of exposure to ^{131}I from nuclear explosions at the Nevada Test Site are discussed. Evidence that irradiation delivered to the neck or upper thorax of infants or young children is associated with an excess risk of thyroid carcinoma, is reviewed. As an average for all Utah infants for the period 1952 through 1955, an estimate of a cumulative thyroid dose from ingested ^{131}I of 5 to 50 rad was made. Infants and children present in the state from 1952 through 1955 received about 50 rad from ^{131}I ingested during that period. Estimates exceeding 100 rad were made for a small population in one area of Utah 110 to 140 miles east of the test site. Some observations on the incidence of surgically treated thyroid disease in Utah are provided as a basis for the future evaluation of the possible association of certain thyroid abnormalities with ^{131}I from fission products originating in Nevada. This study revealed that thyroiditis increased 2-fold and thyroid cancer increased almost 4-fold. The cancer increase was observed for both sexes but primarily in the 20- to 29-yr age group. When observed frequencies of thyroid cancer were compared with expected numbers derived from other incidence studies, the excess in Utah was most marked in the most recent 5-yr period. Continued study is proposed to determine whether a true excess of thyroid cancer is occurring in Utah and, if so, what genetic or environmental factors may be associated with it. (BBB)

15085 MECHANISM OF ABNORMAL HUMAN CHROMOSOME FORMATION. Sotomura, Akira (National Inst. of Genetics, Mishima, Japan). Nagasaki Igakkai Zasshi, 40: 704-8(Aug. 1965). (In Japanese).

Abnormal chromosomes induced by radiation exposure have been observed. The frequency of abnormal chromosomes in Western countries and Japan is compared and the mechanisms of their occurrence are discussed. The role of radiation in causing chromosome anomalies and their appearance in atomic bombing survivors are also considered. The incidence of abnormal chromosomes in mongolism in Europe or North America is about 1 per 600 to 700 infants. In Japan the incidence of mongolism is 1 per 1200 in infants (0.083%) and 1 per 1000 in 5 to 12-yr-old children. The incidence of abnormal chromosomes was also investigated in patients with anomalies in sex differentiation. In Europe and North America there were 1 to 3% of XXY type chromosomes in males and 0.4 to 0.7% type chromosomes in females. The incidence of XXY type chromosomes, including a slight proportion of the XXXY type, in 412 Japanese patients was 1.5%. The mechanism of occurrence of abnormal chromosomes has been studied in mongolism, Klinefelter's syndrome, and Turner's syndrome. The occurrence of mongolism is attributed to abnormality of the 21st chromosome. The chromosomes implicated in Klinefelter's syndrome were formed from the XXY, XXXY, XYYY, XXXY, and mosaic types. The basic type of the sex chromosomes was XXY, which was formed due to the nondisjunction of the X chromosome during gamete formation. The abnormal XO type sex chromosome in Turner's syndrome is due to the nondisjunction of the X chromosome in the gamete. Besides XO type chromosomes, the patients with Turner's syndrome also show some abnormalities in the morphology of chromosomes, e.g., XA or XX type. (BBB)

15086 EFFECT OF RADIATION DOSE RATE ON THE FREQUENCY OF CHROMOSOME ABERRATIONS INDUCED IN HUMAN LEUKOCYTES IRRADIATED IN VITRO. Wong, An-chi; Chou, Shing-ting. K'o Hsueh T'ung Pao, 17: 294-8(Apr. 15, 1966).

Leukocytes in human blood were x irradiated at dose rates of 3, 31, or 202 R/min for total doses of 30 to 240 R. The cells were then cultured and chromosome anomalies scored. The results of covariance analysis showed that there were significant differences between the frequencies of aberrations induced by dose rates 31 R/min and 202 R/min in total chromosome breakage, 2-hit aberrations, and 1-hit aberrations. Regression curves for 1-hit and 2-hit chromosome aberrations for dose rates revealed a dose-square relation to be significant at the highest dose rate (202 R/min) for both 2-hit and 1-hit aberrations, but not significant at the dose rate of 31 and 3 R/min. Thus, there is evidence in human cells that at reduced radiation dose rates in a certain range, the frequency of all types of chromosome aberrations may be reduced. This fact is of interest for radiation protection. (BBB)

15087 LEUKEMIA CHROMOSOMES IN SUBJECTS EXPOSED TO IONIZING RADIATION. Kumatori, Tosiyuki; Ishihara, Takaaki. Nagasaki Igakkai Zasshi, 40: 709-14(Aug. 1965). (In Japanese).

The occurrence of chromosome abnormalities in subjects exposed to ionizing radiation was observed in Thorotrast-injected persons, ^{131}I-treated subjects, persons exposed at the Bikini nuclear tests, Japanese survivors of atomic bomb explosions, and occupationally exposed radiation users. These irradiated subjects showed a high incidence of chromosome abnormalities. The 12 Thorotrast recipients studied showed a high incidence (average of 10.92%) of chromosome abnormalities, including the presence of rings, dicentrics, and other abnormal chromosomes, e.g. exchanged or minute chromosomes with increased fragments. At 48 to 120 hr after ^{131}I administration in 4 hyperthyroid patients, there were the dicentric and ring formations in chromosomes of peripheral leukocytes; an increase in fragments and in transient chromosome changes was also observed. Bikini natives subjected to irradiation also showed a high incidence of chromosome abnormalities, an average of 9.42%. The incidence of dicentrics was lower than that of Thorotrast-injected and ^{131}I-treated subjects, and there were no ring chromosomes. However, a high incidence of minute forms (3.35%) and stable monocentric chromosome abnormalities was observed. In 6 Japanese atomic bomb survivors, 3 showed epicentric chromosomes, in 1 ring chromosomes, and in 4 other chromosome abnormalities. (BBB)

15088 NOTES ON SENSITIVITY OF MALE GERM CELLS IN IMMATURE MICE AT DIFFERENT AGES TO X IRRADIATION. Itagaki, Gentaro (Hirosaki Univ., Japan). Kaigobaku Zasshi, 41: 86-104(Apr. 1966).

Testes of immature mice, 1, 2, 3, 4, and 5 weeks old, were irradiated with 300-R doses of x rays, and the course of damage and recovery of the testes was investigated on the basis of weight of testes, the dia of seminiferous tubules, and quantitative histological analyses of spermatogenic cell populations 1 to 6 weeks after irradiation. The pattern of decrease and recovery of testis weight was explained in terms of changes in the population of spermatogenic cells after irradiation. Evidence was presented for a close correlation between shrinkage and recovery of seminiferous tubules and damage and restoration of the spermatogenic cell populations. Type B spermatogonia were more sensitive to x rays than type A spermatogonia, while the rate of cellular regeneration of type B was low. Although a large proportion of spermatogonia was damaged by x rays, some underwent one or more divisions before generation. Some spermatocytes originating from irradiated

spermatogonia completed the formation of spermatids and spermatozoa. A marked extreme decrease in spermatids and spermatozoa suggested that cell death occurred in both spermatogonia and spermatocytes. Primary spermatocytes irradiated at prophase underwent the first meiotic metaphase, but at this stage and anaphase, they showed degenerative changes and chromosomal aberrations. A difference in sensitivity to x rays was evident between primary and secondary spermatocytes on the basis of the frequency of spermatids. Spermatids developed from undamaged spermatocytes were transformed into apparently healthy spermatozoa, and irradiated spermatids developed into apparently normal spermatozoa. Sertoli cells persisted in damaged seminiferous tubules, demonstrating their radioresistance. (BBB)

15089 HISTOLOGIC EFFECTS OF THERAPEUTIC DOSES OF RADIOACTIVE IODINE. Vickery, Austin L. Jr. (Massachusetts General Hospital, Boston). Bull. Pathol. (Chicago), 8: 8; 15(Jan. 1967).

Early and late effects of therapeutic doses of ^{131}I on the microscopic morphology of the thyroid gland are described. Interstitial edema, cytoplasmic swelling, and granularity were seen within the first few days following ^{131}I administration. Cell necrosis and acute inflammatory cell infiltration were possibly only focal phenomena or were entirely absent. Desquamation of follicle cells with accentuation of cytoplasmic changes and signs of nuclear atypism were sometimes evident at two weeks. The interstitial edema was gradually transformed into a general thickening of the stroma accompanied by a decrease in follicle size. The early, acute sublethal effects were therefore subtle and gradual. After six weeks, chronic histologic alterations included interstitial fibrosis, cytoplasmic swelling with vacuolation and eosinophilic granularity similar to the appearance in oxyphil cells, atypical and giant nuclei, and a generalized tendency for formation of smaller follicles. The bizarre nuclei constituted the most striking single feature of the late phase of therapy and were sometimes the only structural abnormality recognizable in some cases. (BBB)

15090 RELATIVE BIOLOGICAL EFFECTIVENESS OF 31-MeV ELECTRONS, ^{60}Co GAMMA RAYS, AND 200-KVP X RAYS MEASURED BY THE REGRESSION RATE OF SPLENIC WEIGHT IN MICE. Morita, Kozo (Nagoya Univ., Japan). Nagoya J. Med. Sci., 29: 239-43(Jan. 1967).

Four-week-old female mice of the ICR strain were whole-body irradiated at doses of 200 to 500 rad of 200-KV x rays and 300 to 700 rad of either ^{60}Co γ rays or 31-MeV electrons. The mice were sacrificed on the fifth day after irradiation, and the weight of the spleen was measured. The regression rate $(a - b)/a$ was computed, where a was the average weight of control spleen and b the average splenic weight of irradiated mice. Thus, the mean weight loss of spleen was expressed as a percentage of the unirradiated controls. Regression equations of the three groups were: 200-KV x rays, $y = 19.1x - 53.9$; ^{60}Co γ rays, $y = 17.6x - 49.8$; and 31-MeV electrons, $y = 22.3x - 79.9$. From these equations, the doses that brought about 50% weight loss of spleen and the relative biological effectiveness, respectively, were as follows: x rays, 230 rad, 1.0; γ rays, 290 rad, 0.79; and electrons, 360 rad, 0.64. Previous reports gave RBE values of 0.61 to 0.87 for ^{60}Co γ rays and 0.5 to 0.87 for β rays as compared to 1.0 for 200-KV x rays. (BBB)

15091 GAMMA-IRRADIATED MOUSE INCISOR. Coady, J. M.; Santangelo, M. V.; Toto, P. D. (Loyola Univ., Chicago). J. Dent. Res., 46: 681-5(July-Aug. 1967).

The effects of γ radiation on the continuously erupting incisor of the mouse, especially on the rate of eruption and the turnover time, were studied in CAF-1 mice given multiple low doses. Mice were subjected to whole-body radiation at the rate of 12 R/day for 100 days, for a cumulative dose of 1200 R, or over a 200-day period for a cumulative dose of 2400 R. After 100 days of low-level, chronic irradiation, no effect was noted on the cell renewal ratio of the incisor. No histologic changes were observed and special histochemic stains showed normal morphology in the incisors. Therefore, 1200 R delivered over 100 days had no discernible effect on the continuously developing incisor of the mouse. A cumulative dose of 2400 R over a 200-day period showed no effect on the eruption of the mouse incisor. Histologically, there were no primary effects in the incisors as a result of irradiation. The special stains showed no change, but several secondary effects (pulp edema and incorporation of pigments in the dentin) were observed toward the fundal end of the incisor. Macroscopic changes after 200 days of whole-body irradiation were observed in the eyes and skin of the mice. These mice also showed a reduced rate of body weight gain. Only one mouse out of 18 did not survive the 200-day period of irradiation; death on the 195th day was caused by pneumonia. (BBB)

15092 ALTERATIONS IN THE FINE STRUCTURE OF THE MATURE RETINA OF DOGS IRRADIATED AS NEONATES. Shively, James N.; Phemister, Robert D.; Epling, Glenwood P. (Colorado State Univ., Fort Collins). Exp. Eye Res., 6: 278-82(July 1967).

Newborn beagles were exposed bilaterally to 150 or 280 R of x or γ whole-body radiation. The eyes were removed seven or 16 weeks after irradiation and were studied by light and electron microscopy. The fine structure of the irradiated neural retina dysplasia is described. At a time when the retina should be fully formed, there was agenesis of the outer segments of the photoreceptor cells, rosette formation, and dysplasia of retina layers extending through the inner nuclear layer. The deeper layers appeared but little affected. Since the eyes were collected several weeks after irradiation, the acute response of damage to cell organelles and cell death was not seen. The dysplasia was bilateral, being most severe at the retina periphery, and appeared to be irreparable since it persisted for at least four months after irradiation. The occurrence of the lesion was dose-dependent and was provoked by dose rates of 5 or 25 R/min. (BBB)

15093 CANCER OF THE PHARYNX. A STUDY BASED ON 2417 CASES WITH SPECIAL REFERENCE TO RADIATION TREATMENT. Lederman, M. (Royal Marsden Hospital, London). J. Laryngol. Otol., 81: 151-72(Feb. 1967).

Postirradiation complications and sequelae of radiotherapy for pharyngeal cancer in a large series of cases are reported. Postirradiation complications were avoidable if the following rules were obeyed: radiotherapists selected cases, avoided using radiation indiscriminately, and did not use it in very advanced or recurrent cases. Technical factors such as the use of large fields, high doses and short treatment times all carried risks. During the course of irradiation treatment fields should be changed in conformity with the change in the tumor and as doses were increased, treatment times should be lengthened. Clinical interpretation of radiation reactions furnished some guide to treatment and they could be controlled by attention to dose and timing of treatments. In this way the patient's discomforts could be minimized and late damaging effects avoided. Possible postirradiation complications that were peculiar to the pharynx stemmed from its close relation to the special sense organs, the central nervous system, and the three anterior cavities consecutively related to it. The organs of sight, smell, hearing, and taste might suffer temporary damage after irradiation. The changes induced in the ear and eye were described. It is unlikely that radiation directly damaged the nervous tissues supplying any of the special sense organs, but later changes might occur in the specialized tissues if their blood supply was damaged by irradiation. In the series of cases of nasopharyngeal neoplasms reported, two patients developed midbrain damage after a course of radiotherapy was repeated for tumor recurrence. A third patient with cerebral vascular disease developed necrosis of part of the temporal lobe of the brain which was verified at operation. There were no cases of radiation myelitis of the spinal cord, but such myelitis could arise when doses of high energy radiation were used in the treatment of tumors with a predilection for posterior triangle metastases, i.e., carcinoma of the nasopharynx and, to a lesser extent, the oropharynx. If the spinal cord must be included in the field of radiation, special technical measures should be taken so as to avoid its excessive irradiation. Complications in the cavities (nasal, buccal, laryngeal) related to the pharynx were also described. The only bones in the face where radionecrosis could be serious and cause serious deformity were the malar bones and the mandible. The treatment of malar or mandibular invasion by cancer should be by surgery and radiotherapy in combination if radionecrosis was to be avoided. In the malar bone, surgery should precede radiotherapy, whereas in the mandible, surgery should follow radiotherapy. (BBB)

15094 CHANGES IN THE RESISTANCE OF ERYTHROCYTES TO HYDROGEN PEROXIDE AFTER WHOLE-BODY X IRRADIATION OF MICE. Sikulova, J.; Pospisil, M. (Inst. of Biophysics, Brno). Folia Haematol. (Leipzig), 88: 63-6(1967).

In view of the possible participation of organic peroxides in radiation toxicity, vitamin E, which has strong antioxidative properties, may play an important role in natural radioprotection of tissues. Change in the sensitivity of erythrocytes to the hemolytic action of hydrogen peroxide is an indirect test of the state of antioxidative functions of the blood. This test was studied in the course of postirradiation syndrome to clarify its possible use for detecting the changes in antioxidative activity of the blood after irradiation. Male mice of the noninbred strain H were x irradiated by single whole-body lethal exposures of 750, 800, and 1000 R. Hydrogen peroxide was added to blood samples which were incubated for 40 to 50 min and the degree of hemolysis determined. The results showed a gradual increase of the erythrocyte resistance to peroxide, approaching 100% at the terminal stage (12th day) of the postirradiation syndrome. No significant relation was found by comparing peroxide resistance and variations in erythro-

cyte concentration. No decrease in the concentration of erythrocytes in blood was detected until the 8th day following exposures of 750 and 800 R (not after 1000 R). An unexpected postirradiation increase of the resistance of erythrocytes to peroxide was found, indicating an enhanced antioxidative activity of the blood. Decreased antioxidative activity in the tissues after irradiation had been previously described. The role of possible changes of blood catalase that would explain the results seemed to be less probable. Fat-soluble antioxidants of vitamin E type exhibited a close relation to the unsaturated fatty acids, preserving their integrity, and elevated fatty acid content in blood, including unsaturated components, had been observed after irradiation of mice. A rise of the easily oxidizable unsaturated fatty acid substrate in blood was probably accompanied by a compensating increase in natural antioxidants, which could be responsible for the increase in postirradiation resistance of erythrocytes to peroxide. (BBB)

15095 EARLY CHANGES IN THE GROWTH ZONE OF RAT INCISORS FOLLOWING IRRADIATION WITH X RAYS. Bily, B.; Soska, J. (Inst. of Biophysics, Brno). Cesk. Stomatol., 64: 246-52(1964). (In Czech).

Studies were made of histologic changes in the growth zone in the apical portion of rat incisors following single doses of x rays, of 200, 1200, 2400, and 4800 R, by examination at intervals of one, three, and seven days after irradiation. Changes appeared only after irradiation with a dose of at least 600 R. According to the dose of radiation and according to the time interval postirradiation, the changes were characterized by varying degrees of edema affecting the growth zone and the apical periodontium, by hyperemia, and structural and regressive changes of cells of the odontogenic epithelium, that later almost completely disappeared following irradiation with doses of 2400 R and more. Damage to and disintegration of the odontogenic epithelial cells resulted in delay or even complete arrest of the hypoplastic enamel and dentin of osteoid character. Mature dental tissues became separated from tissue damaged by radiation by hyaline calcifying masses which eventually resembled osteodentin. Reparative changes, that teeth were still capable of when irradiated with doses of up to 2400 R, were characterized by connective tissue proliferation in the originally edematous tissue and by organization of hemorrhagic foci in conjunction with restoration of the structure of the odontogenic epithelium. Restitution was usually complete after doses not exceeding 1200 R; permanent functional damage to the growth zone, however, resulted if the dose surpassed 1200 R. (BBB)

15096 GENETICS EFFECTS OF IRRADIATIONS IN THE CASE OF MAN. Leonard, Alain (Centre d'Etude de l'Energie Nucleare, Mol, Belg.). Belgicatom, Ass. Belge Develop. Pac. Energ. At., Bull. Inform., No. 52, 1-4(Oct. 1964). (In French). (BLG-398).

Ionizing radiation given to the embryos or to the germ cells can have some influence on the next generations. When the germ cells are irradiated some change in sex ratio and an increase in intrauterine death and in the number of abnormalities are recorded. According to their differentiation, the embryos can die or show some malformations. (auth)

15097 WHOLE-BODY IRRADIATION AND RADIOCARCINOGENESIS. Londono, Alvaro Ariza (Instituto Nacional de Cancerologia, Bogota). Rev. Interamer. Radiol., 2: No. 3, 19-26 (1967). (In Spanish).

A brief review is presented of data obtained from diagnostic, therapeutic, and accidental exposures to high doses of whole-body radiation. The review shows evidence of a linear relation between dose and carcinogenesis. Fractionated doses over a long period of time do not seem to present a problem. No direct correlation could be observed between dose and clinical improvement of carcinomas either with massive radiation or with lower fractionated doses. 33 references. (J.S.R.)

15098 ERYTHROPOIESIS IN THE RAT UNDER CONTINUOUS γ-IRRADIATION AT 45 RADS/DAY. Blackett, N. M. (Inst. of Cancer Research, Surrey, Eng.). Brit. J. Haematol., 13: 915-23 (Nov. 1967).

The use of bone marrow transplantation techniques, have provided much information on the properties of the stem cells that are responsible for recovery of haemopoiesis in irradiated animals. However, relatively little work has been reported in which an attempt was made to compare results obtained with these techniques with measurements of the rate of production of mature blood cells. This may in part be due to the fact that the techniques used were not specific for one particular cell type and also because of the difficulty of estimating the production rate of mature blood cells. Measurements specific for erythroid tissue may be obtained using ^{59}Fe and in the present study were used to investigate the response of rats to continuous γ irradiation at 45 rads/day. The incorporation of radioactive iron into newly formed red blood cells entering the circulation reflects the level of red cell production and, combined with transplantation of bone marrow cells, provides a measure of the capacity of stem cells to proliferate. The extent to which these and other methods provide a true measure of red cell production and numbers of stem cells is discussed. (auth)

15099 EFFECT OF IONIZING RADIATION ON MAMMALIAN REPRODUCTION. Chu, Rung. K'o Hsueh T'ung Pao, 3: 6-18 (Mar. 1963). (In Chinese).

The effects of irradiation on the reproductive performance of mammals, especially of rodents, are reported. When the male animals were irradiated with 300 to 1000 R and mated with non-irradiated females, variations in their reproductive ability could be divided in 3 stages: (1) A short time after irradiation, the animals still showed fertility; (2) a period then followed of deficient reproductive ability; and (3) recovery of fertility followed at a later stage. Irradiation of adult male albino rats with 200-R doses of x rays did not show any effect on reproduction. However, as the irradiation dose increased to 300 R, the size of litter was greatly decreased. In 500-R irradiated rats the reproductive performance of most animals decreased markedly and there was at least a 3-month period of infertility at 40 to 50 days after irradiation. When the irradiation dose increased to several thousand or to 10,000 R, the animals became permanently sterile. The disturbances induced by irradiation of the ovary were more severe than in the testis. A dose of 50 to 350 R of irradiation in adult female albino rats resulted in permanent infertility after 3 to 4 weeks postirradiation, and even 20-R irradiation affected reproductivity. A possible correlation between irradiation effects and secretion of sex hormones was also investigated. The interstitial cells of testis and their testosterone secretion were not affected by the irradiation, nor was production of estrogen affected by the irradiation doses used. (BBB)

15100 EXPERIMENTAL AND HISTOLOGICAL STUDIES OF THE ACUTE GENERALIZED INFLAMMATION OCCURRING DURING THE TELECOBALT THERAPY OF CANCERS OF FEMALE GENITAL ORGANS. Matsuoka, Yoshito (Kumamoto Univ., Japan). Nippon Sanka Fujinka Gakkai Zasshi, 17: 1129-38(Oct. 1965). (In Japanese).

Histological and serological analyses were performed on acute generalized reactions that occurred during telecobalt therapy of cancers of female genital organs. In ten patients with inflammations and 25 without, the intracutaneous and passive cutaneous anaphylaxis reactions were studied. Extracts of the irradiated cancer tissues were used as antigens. Reactions were negative in patients with and without inflammations. Using the somatic antigens of coliform bacilli and hemolytic streptococci and staphylococci, passive hemoagglutination tests were done in seven patients with inflammation and 37 without; the fluctuations in agglutination titers were determined. No significant fluctuations were observed in the agglutination titers for the coliform bacilli and hemolytic streptococci; the agglutination titers for hemolytic staphylococci rose significantly in three of seven patients at the peak of the inflammatory reaction. Results of the histological analyses revealed that pathological changes were both in the corium and epidermis, although mostly in the corium. They were primarily observed in the blood vessels and connective tissues. It was concluded that the inflammations that occurred were brought about in part by allergic reaction to the somatic antigens of the bacterial flora of the genital region. (NSA of Japan) (TSS)

15101 EXPERIMENTAL STUDIES ON METASTATIC DISSEMINATION OF TUMOR CELLS IN CIRCULATING BLOOD. PART 2. Kiyonaga, Akinori (Kyushu Univ., Fukuoka). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 12: 227-34(Oct. 1965).

The effects of pretreatment of rats with ^{60}Co γ rays, prednisolone, or endoxan on the dissemination and proliferation of AH 130 cancer cells, injected into the tail vein, were investigated. Whole-body irradiation with 100, 300, and 600 R was given, and 1×10^7 cancer cells were injected 72 hr after irradiation. Irradiation at the same doses was given in a control group, and it was confirmed that no deaths from irradiation occurred in the 60 day observation period. After whole-body irradiation and tumor cell injection no deaths from cancer were seen in the eight groups with 100 and 300 R irradiation. In the 600 R group, 60% died from cancer and the mean survival time was 24 days. No marked difference was found from the control group. Gross anatomical findings revealed metastases to the lung and lymph nodes in all cases, to the liver in two cases, and to the kidney in one, and histologically to the kidney in one. As with γ irradiation, administration of prednisolone in large doses and endoxan before inoculation of cancer cells augmented hematogenic metastasis. In addition, effects of the route and time of administration endoxan in preventing hematogenic metastasis were investigated. It was found that the admin-

istration of endoxan after cancer cells formed a small focus (following intraperitoneal transplantation) or after they had begun to proliferate (following systemic transplantation) was ineffective. It was effective only if it was administered at a time when cancer cells were free in the bloodstream. Continuous administration in small doses was more effective than that of single large doses. (BBB)

15102 A SHIFT OF SEX RATIO IN THE PROGENY FROM IRRADIATED MALES IN DROSOPHILA MELANOGASTER. Moriwaki, Daigoro; Tobari, Izuo; Ohba, Shigeru; Kitagawa, Osamu; Tobari, Yoshiko N.; Ikeda, Hiroshi (Tokyo Metropolitan Univ.). Nippon Idengaku Zasshi, 42: 23-38(Feb. 1967).

Sex ratio changes in the progeny from males x irradiated with doses up to 3 KR at different germ cell stages in D. melanogaster were investigated. The sex ratio (female/male) fell to the lowest level when the progeny developed from males mated six to eight days after irradiation, and returned to the control level in the progeny from males mated at 14 to 16 days. The sex ratio decreased with increasing dose. Nonirradiated younger males produced more male than female offspring, a tendency that decreased with age. The sex ratio shift changed according to the frequency changes of both induced dominant lethals and elimination of sex chromosomes, showing a negative correlation, and all the frequencies coincidentally reached a peak on the 7th to 8th days after irradiation. The stage-frequency relation for the sex chromosome elimination was fundamentally the same as that for the dominant lethals, suggesting that the two phenomena probably occur through the same mechanism. The highest sterility was found from the 6th to the 8th days post-irradiation. The results suggested that sperm utilized during these days represented cells irradiated during the meiotic stages. The proportion of X chromosome elimination (S_e) and X chromosome dominant lethals (S_x) to the total shift of the sex ratio (S) was estimated in each of the 3 different germ cell stages, i.e., postmeiosis, meiosis, and premeiosis. For the present data, the contribution of S_e and S_x to S was nearly the same at the meiotic stages, while at the other stages S_x played a greater role than S_e. (BBB)

15103 SPECTRUM ANALYSIS OF RESIDUAL EEG CHANGES FOLLOWING POST-NATAL X IRRADIATION IN RATS. Kobayashi, Satoshi; Eidelberg, Eduardo (St. Joseph's Hospital, Phoenix, Ariz.). Electroencephalogr. Clin. Neurophysiol., 23: 463-7 (Nov. 1967).

Newborn rats were irradiated within the first 24 hr after birth, and their cortical electroencephalographic (EEG) activity was recorded and quantitated at a post-natal age when the adult EEG pattern should have been fully established. Whether such EEG changes can be prevented by pretreatment with a radioprotective compound, β-aminoethylisothiuronium bromide (AET), was also examined. It was found that no residual EEG alterations could be detected following a single dose of 78 R. Doses of 200 and 300 R produced a definite decrease in energy content at the lower frequencies (below 10 cps), the effects being similar with both these doses. Pretreatment of the animals with AET prevented the changes induced by a dose of 200 R but failed to do so when a dose of 300 R was used. Some mild but definite residual changes in the EEG were produced by AET. The earlier finding of a sharp reduction in the development of dendritic expansions of cortical neurons after irradiation support an interpretation of the present findings, in which the larger than normal extracellular space (for that age) would result in EEG activity with the characteristics of that from much younger animals. An alternative explanation would link directly the reduced development of neuropil structures with the EEG changes. (BBB)

15104 EFFECTS OF IONIZED AIR ON STRESS BEHAVIOR. Nazzaro, James R.; Jackson, Donald E.; Perkins, Lloyd E. Med. Res. Eng., 6: 25-8(Third Quarter 1967).

The effect of radiation-induced air ions on 90-day-old Sprague-Dawley rats was investigated. The ions were generated by a β emitter (50 μCi of tritium gas sealed in zirconium on stainless steel). The β particles, either by electron capture or by combining with nuclei, produced negative and positive ions. An adsorber in the head of the emitter allowed the selection of ions by changing the polarity of the adsorber. An ion generator was placed in the test cage so that the animals would be constantly exposed to ion concentrations. A differential effect of negative and positive ions on a conditioned emotional response in rats was demonstrated. Following a five day control period, half the animals were subjected to positive and half to negative ions. After eight days, the conditions were reversed. Five animals showed significant changes in stress response rate following exposure to ions. The predictions were based on the hypothesis that negative ions parallel the action of reserpine. Results suggest that negative ions, like reserpine, reduce anxiety but facilitate learning, whereas positive ions may increase anxiety but interfere with learning. The possibility that individual differences in ion sensitivity exist was discussed. (BBB)

15105 CERTAIN RESULTS OF RADIOIODINE THERAPY IN HYPERTHYROIDISM. Hennig, K. (Radiologische Klinik, Dresden). Deut. Gesundheitsw., 20: 822-7(1965). (In German).

The functional potential of the thyroid is reduced after radioiodine treatment by injury and destruction of follicular cells. During ^{131}I therapy the radiation exposure in the gonadal area amounts to ~30 rep, which is the same as from an x-ray study of the small and large intestine. Studies of treatment of hyperthyroidism in 102 patients by ^{131}I where 5000 to 12000 rep were administered are reported. The single doses administered ranged from 5 to 40 mCi each, but when more than one dose was given, the total was as high as 80 mCi. In 13 patients with malignant exophthalmos the hypophysis was irradiated with a focal dose of 1500 R. For better radiation protection and supervision the ^{131}I treatment was followed up after three months and then semiannually. Only three patients developed a hyperthyroidism after treatment that required hormone substitution. (BBB)

15106 PRELIMINARY OBSERVATIONS ON OCULAR EFFECTS OF HIGH-POWER CONTINUOUS CO_2 LASER IRRADIATION. Fine, Ben S. (Armed Forces Inst. of Pathology, Washington, D. C.); Fine, S.; Peacock, George R.; Geeraets, Walter J.; Klein, Edmund. Amer. J. Ophthalmol., 64: 209-22(Aug. 1967).

A study was carried out to evaluate in vivo the potential hazards associated with radiation from a high-power CO_2 laser and to examine clinically and histopathologically the changes that occur. These experiments were also designed to show whether unexpected intraocular changes occur in vivo, changes that could not be predicted by theoretical considerations, and to evaluate such changes if found. Effects of the continuous CO_2 laser (wavelength 10.8 μ), operating at power levels >1000 w were of great interest because of its relatively low attenuation by the normal atmosphere in comparison with ruby (0.6943 μ) and neodymium (1.06 μ) lasers. Irradiation was directed to the center of the cornea of rabbit eyes at total irradiation energies of 3.0 to 20 J. An intense white central corneal opacity, the dia of the beam spot, was produced by 3 J (15 J/cm^2). As the power level was increased stepwise, the center of each lesion lost tissue (ablation) and became more charred. The charring extended peripherally, reducing the opaque area to a narrow marginal ring. Corneal thickening and central crater formation occurred that, at high power levels, penetrated into the anterior chamber, along with ejection of an aqueous stream. Deep intraocular changes did not occur in the nonpenetrated eye within the limited time interval (2 hr) between irradiation and observation. A form of corneal thickening, termed fusion of corneal lamellae, that occurred at the periphery of the corneal lesion lost affinity for alcian blue, Masson, and Van Gieson stains. Electron microscopy of this region revealed scattered amorphous foci along the collagen fibrils in the stromal lamellae. (BBB)

15107 POSTRADIATION CARCINOMA OF MALE BREAST BILATERALLY. Orme, S. Kirby; Chambers, Robert W.; Johnson, Robert H. J. Amer. Med. Ass., 201: 707(Aug. 28, 1967).

Presumptive radioinduced carcinoma in both breasts of a 24 yr old man is reported. At age 12 the patient had noted button-like enlargement of both breasts associated with intermittent sharp pain. Instead of surgical excision, x-ray therapy was used. Both nipples, areolae, and small perimeters of adjacent skin were irradiated twice weekly for several months. During treatment, the cone of the x-ray machine rested on a lead shield that protected other parts of the thorax. The amount of irradiation given is unknown. After these treatments, the patient noted that his nipples became abnormally red and tender following exposure to sunlight. No abnormalities were found at ages 17 and 21. At age 23, intermittent sharp pains were noted in each breast, with subsequent progressive scaling and ulceration of the nipples and areolae. Each breast contained a firm 3 cm diameter mass, fixed to the overlying skin, but not to the pectoral muscles. A soft 1 cm nodule was palpable in the left axilla. Adenocarcinoma of both breasts was confirmed by biopsy, and bilateral simultaneous radical mastectomies were performed. Carcinoma of the breast was described previously in women following irradiation of the chest and in a 50-year-old man who had carcinoma 20 years after receiving large doses of irradiation for a mediastinal tumor. The present patient provides additional evidence against the use of unnecessary x-ray therapy. (BBB)

15108 ULTRAVIOLET LIGHT-INDUCED KININ FORMATION IN HUMAN SKIN. Epstein, John H. (Univ. of California, San Francisco). Arch. Dermatol., 95: 532-6(May 1967).

The in vivo response of human skin to erythemogenic uv radiation (<3150 Å) was evaluated in six normal and three atopic subjects utilizing a carbon-arc source and dermal perfusion techniques. Kinin and histamine bioassays of the perfusion fluid revealed no evidence of histamine release. In contrast, kinins appeared within 21 min after completion of the exposures in the six normal subjects. Initiation of the perfusions 3 and 24 hr after the uv exposure showed no kinin formation. No kinins were detected in atopic subjects despite development of normal delayed erythema reactions. Thus, the kinin response was transitory in nature, and was not responsible for the production or persistence of the delayed sunburn erythema. (BBB)

15109 AN ELECTRON MICROSCOPIC STUDY ON THE RETICULOENDOTHELIAL SYSTEM IN THE BONE MARROW. Watanabe, Yonosuke (Keio Univ., Tokyo). Tohoku J. Exp. Med., 89: 167-76(June 25, 1966).

The fine structure of reticuloendothelial cells and fibers after the whole-body irradiation with ^{60}Co is described. In the early stages after irradiation (one and two days), marked degeneration of both blood cells and reticulum cells was noted. Four days after irradiation, hematopoietic cells had almost completely disappeared. Although the spaces originally occupied by the hematopoietic parenchyma were largely replaced by the dilated sinuses and proliferated fat cells, wide extravascular spaces remained, in which no cellular elements were present. Nine days after irradiation, however, the proliferation of the reticulum cells became prominent and the extravascular spaces were filled with those cells. Large numbers of plasma cells were also present, intermingled with reticulum cells. The proliferated reticulum cells were quite irregular in shape and possessed many elongated cytoplasmic processes that were intertwined with those of adjacent reticulum cells. The rough-surfaced elements of the endoplasmic reticulum, in particular, showed a marked increase in numbers. They took the form of flattened vesicles and frequently showed a lamellar arrangement. Phagosomes were present in the proliferated reticulum cells in varying numbers but not so numerous as in normal ones. Closely opposed to the surface of reticulum cells were deposits of dense material similar to that composing the basement membrane surrounding fat cells. These depositions frequently extended for a considerable distance along the cell surface and showed a fiber-like appearance. This material was not observed in reticulum cells in normal bone marrow. This material may correspond to argyrophil fibers which were observed in light microscopic preparation because of its resemblance to the material composing the basement membrane that is known to be strongly impregnated by silver staining. (BBB)

15110 LEUKOPLAKIA OF THE CONJUNCTIVA: A COMPLICATION OF X-RAY THERAPY FOR CARCINOMA OF THE EYELID. Kopf, Alfred W.; Allyn, Burton; Andrade, Rafael; Strickland, Maurice (New York Univ., N. Y.). Arch. Dermatol., 94: 552-7(Nov. 1966).

Three case reports are cited to illustrate the occurrence of leukoplakia of the conjunctiva as a complication of x-ray therapy. Of 1421 histologically confirmed basal-cell epitheliomas of the skin, 23 (1.6%) were localized on eyelids and all 23 lesions were treated with 100-KV x radiation. Usually, 680 R was administered every other day for 5 treatments to a total of 3400 R. The area irradiated included a zone of 5 mm of apparently normal skin beyond the grossly visible borders of the lesion. The method of shielding is shown. Upon follow-up over 5 to 10 yr, 3 patients treated for basal-cell epitheliomas of eyelids developed plaques of leukoplakia on the palpebral aspect of the conjunctiva within the irradiated area. Other complications which have been reported from the use of x rays include telangiectasias of the conjunctiva, permanent loss of eyelashes, ulceration of the eyelids, ectropion and entropion, atrophy of the sclera, punctate keratitis, corneal vascularization, iritis, atrophy of the iris, cataract, and stenosis of the lacrimal ducts resulting in epiphora. Many of these sequelae, especially the more serious ones, resulted from overdosage or poor shielding technique. The complication reported here, following x-ray treatments for skin cancer of the eyelids, has been described before as epidermatization and keratinization. It is believed that this benign leukoplakic plaque is a radiation keratosis rendered white as a result of maceration by tears. It was likely that a significant percentage of the radiation absorbed by the eyelid came from backscatter from the lead shield protecting the ocular globe. In attempts to reduce the amount of backscatter radiation, an eyeshield was constructed which had a core of 0.92 mm lead electroplated with 0.25 mm of copper and finally coated with a 0.5 mm layer of aluminum. Before insertion into the conjunctival cul-de-sac, the shield was dipped into heated paraffin and allowed to cool. The paraffin has the dual purpose of providing a very smooth surface and further absorbing backscatter. (BBB)

15111 EFFECT OF X IRRADIATION ON THE RODENT TOOTH OF THE RAT. Bily, B.; Soska, J. (Inst. of Biophysics, Brno). Cesk. Stomatol., 63: 25-35(1963). (In Czech).

The effect of x irradiation was studied on the growing rodent tooth of fullgrown rats, following doses of 200, 600, 1200, and 2400 R. Histologic examination was done at intervals of 2, 4, 7, and 10 weeks after irradiation. Doses of 600 R caused temporary damage to the cells of the growth zone, which differentiate into odontoblasts and ameloblasts and which after irradiation produced temporarily hypoplastic dentin and enamel. The tissue defects had a marble-like character. In the pulp, regressive changes were also noted. Sometimes deformation of the dental bed was observed as well as fractures of the erupted crown. Doses of 1200 R caused similar, though more severe changes. In addition, usually at the borderline of the pre- and postirradiation zone there was a layer of calcified tissue. The pulp of the postirradiation area was smaller on cross section. Obvious deformation of the dental bed occurred. Fractures of the erupted crowns of incisors were frequent. After doses of 2400 R almost complete destruction of the cells of the growth zone was observed, and even after 70 days following irradiation growth and eruption of the tooth were arrested. The narrow periodontal membrane in the postirradiation zone lost its typical structure. In the apical spaces of the deformed dental bed large vacuoles which were later replaced by bony tissue were seen. Calcified tissue separated the preirradiation part of the tooth from the damaged portion. (BBB)

Radiation Effects on Plants

Refer also to abstracts 14905, 14981, 14983–14985, 14988, 14991–14993, 14996–14998, and 15069.

15112 STUDIES ON THE STRONTIUM UPTAKE OF THE CLADONIA ALPESTRIS THALLUS. Tuominen, Yrjo (Univ. of Helsinki). Ann. Bot. Fenn., 4: 1-28(1967).

Strontium uptake of the C. alpestris thallus was postulated to consist essentially of an accumulation of the cation in the thallus caused by the electrical field of ionic groups on the thallus surface. Thallus homogenate acted as a polybasic macromoleoule. Strontium uptake by the thallus depended markedly on the pH of the external solution, and was low at pH 3. When the acidity of the solution decreased, the uptake increased to a maximum, at pH 7 to 9, of about 0.2 to 0.3 meq/g air-dry weight of lichen. Lichen samples from various regions in Finland revealed about a two-fold maximum difference in capacity at the natural pH of thallus suspension, pH 3 to 4. Strontium uptake and the H^+ dissociation of C. alpestris were thermodynamically reversible in the biological pH range. Temperature dependence of Sr uptake was small. The standard heat of reaction was about +1.7 to +2.0 Kcal/mole. Changes in the standard free energy (–4 to –5 Kcal/mole) and entropy (+23 EU) indicated the process to be a cation exchange that was complicated by the possible formation of a chelate compound and hydrogen bonding between carboxyl groups. Kinetics of Sr uptake followed a first order rate. The activation energy was about 2.5 Kcal/mole; the limiting factor was film diffusion. Titration curves of numerous species (the thalli of C. alpestris, Umbilicaria deusta, Parmelia saxatilis, and the species pair Usnea dasypoga + U. comosa) apparently contained different kinds of ionic groups. In the pK range of 2.7 to 3.3 these groups were evidently carboxyls of pectin-like substances. However, in some species Sr uptake seemed to be based mainly on other substances having a pK of 5 to 7. Possibly they were organophosphoric compounds or side-chain carboxyls of proteins. The groups having a pK of about 8 were phenolic. Usnic acid, which has a wide distribution among lichens, was found not to participate in the Sr uptake process. There was apparently a correlation between the uronic acid content of the thalli of different lichen species and their Sr uptake. Epiphytic species had a higher Sr uptake and uronic acid content than species growing on the ground. It was concluded that the Sr uptake of C. alpestris was purely a physical process, with no indication of metabolic activity being required. (BBB)

15113 THE EFFECT OF HOMOLOGOUS DESOXYRIBONUCLEIC ACID ON THE DNA OF IRRADIATED SEEDS. Tokarskaya, V. I.; Miloshevich, M.; Kanazir, D. (Inst. of Biological Physics, Moscow. Inst. of Nuclear Research, Belgrade). Radiobiologiya, 7: 511-15(1967). (In Russian).

Seeds of the Yugoslavskii and Pobeditel varieties of the pea received doses of 35 and 50 kR of gamma-radiation at 700 R/minute. Seeds were soaked for 48 hours or 5 days in tap-water and in solutions of homologous nucleic acids (50 micrograms/liter) or DNA alone (5, 10, and 25 micrograms/liter). Unirradiated seeds served as controls. It was shown that homologous DNA participates in the recovery of the DNA structure in the embryos of seeds damaged by radiation. (JPRS)

15114 PHOTOREACTIVATING ENZYME FROM NEUROSPORA CRASSA. Terry, Claude E.; Setlow, Jane K. (Oak Ridge National Lab., Tenn.). Photochem. Photobiol., 6: 799-803(Nov. 1967).

Neurospora crassa exhibited photoreactivation that was temperature-dependent and had an action spectrum with peak efficiency in the 400-nm region, suggesting a direct photoreactivation mechanism. If the photoreactivating activity of N. crassa was due to a photoreactivating enzyme, the activity should be heat and protease labile. The extracts should also mediate uv-induced splitting of thymine-containing dimers. The experiments described show that both of these expectations were fulfilled. The wavelength dependence of in vitro photoreactivation was also studied, to characterize the enzyme and for comparison with the in vivo spectrum. The extracts were shown to contain photoreactivating enzyme by the criteria of ability to split thymine-containing dimers and to increase the transforming ability of uv-irradiated Hemophilus influenzae DNA. The latter activity was heat-labile and was destroyed by trypsin. The action spectrum of such in vitro photoreactivation was a simple one (with a single maximum at 405 nm in the range 313 to 435 nm), differing from the more complicated in vitro spectra for yeast and Escherichia coli. However, the in vitro Neurospora spectrum coincided closely with its in vivo spectrum suggesting that there was little or no indirect photoreactivation in Neurospora. It was concluded that the Neurospora photoreactivating enzyme was probably of a different type than those of yeast and Escherichia coli. (BBB)

15115 CHANGE OF THE DROUGHT-RESISTANCE OF PLANTS IRRADIATED WITH ^{60}Co GAMMA RAYS. Savin, V. N.; Stepanenko, O. G. (Agrophysical Scientific Research Inst., Leningrad). Radiobiologiya, 7: 619-22(1967). (In Russian).

Peppermint and sunflower (Perevodik) plants grown under laboratory conditions were irradiated with ^{60}Co gamma-rays (peas with 3, 6, 8, and 10 kR and sunflowers with 1.0, 1.5, and 1.0 kR, at 290 R/min). The results showed that irradiation which retards growth of the main stem leads to an increase in the content of dry matter in the leaves and an increase of the drought-resistance of the plants. (JPRS)

15116 EFFECT OF IONIZING RADIATION ON THE RESPIRATION AND BIOCHEMILUMINESCENCE OF PLANT GERMINANTS. Mamedov, T. G.; Popov, G. A. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya, 7: 609-12(1967). (In Russian).

Peas of the Pioneer variety (4–5 day germinants), after measurement of their rates of absorption of oxygen and excretion of CO_2, were put in several groups of 50–60 each with identical biochemiluminescence and irradiated at 550 R/min. The intensity of biochemiluminescence and respiratory gas exchange were measured daily for 5–7 days after irradiation. With elevation of the temperature from 10 to 50° the intensity of respiratory gas exchange increases steadily and the CO_2/O_2 coefficient declines, evidently as a result of processes requiring oxygen and accompanied by biochemiluminescence. Under ionizing radiation the intensity of respiratory gas exchange is maximal one day after irradiation, whereas that of biochemiluminescence is maximal after 3–4 days. This indicates that ionizing radiation initiates oxidative processes which develop after irradiation and are accompanied by luminescence and are independent of respiratory gas exchange. (JPRS)

15117 EFFECT OF RADIATION ON ORGANOPHOSPHORUS COMPOUNDS IN PLANT TISSUES. Golikova, O. P.; Khodos, V. N. (Inst. of the Physiology of Plants, Kiev). Radiobiologiya, 7: 613-18(1967). (In Russian).

Experiments were conducted under laboratory and field conditions with peas and spring wheat. The pea seeds received 250 and 1000 and the spring wheat 1000 R of gamma radiation at 50 R/sec, and the peas also received neutron irradiation of 15 and 1000 R at 15 R/minute. The plant stems were soaked in a medium containing ^{32}P to introduce radioactive phosphorus. The results showed that small doses of ionizing radiation caused some activation of growth, accumulation of dry mass and grain formation, while large doses retarded those processes. Disturbances of the rate of metabolism of phosporylated compounds depended on the dose and appeared at doses which growth disturbances were not evident. (JPRS)

15118 A NOTE ON THE INDUCED HAIRINESS IN COLCHICINE AND COLCHICINE-CUM-IRRADIATED PLANTS OF ZEA MAYS. Siddiq, E. A. (Indian Agricultural Research Inst., New Delhi). Proc. Indian Acad. Aci., Sect. B, 65: 165-6(Apr. 1967).

A profuse hairiness was observed invariably in most colchicine-treated maize plants. Hair scraped from the upper epidermis of colchicine-treated plants was 1½ times longer than that of control plants. A further increase in hair length was seen in colchicine-treated irradiated plants. There was proportionate increase in hair length with increasing radiation dose. The hair length in the colchicine-treated plants was 1.32 times that of the controls while in colchicine-treated plants also receiving 6000 R it was 1.9 times and with 10,000 R nearly 2.6 times that of control plants. It is known that viscosity changes in the cytoplasm occur following irradiation and increased cell elongation has been frequently observed in the cells of tissues exposed to radiation. Thus, the increase in the length of the hairs observed in colchicine-treated irradiated seedlings appears to be due to a greater degree of cell expansion. (BBB)

15119 STUDIES ON THE FREQUENCY OF INDUCED CHLOROPHYLL MUTATIONS AFTER EMS, NEUTRON, AND X-RAY TREATMENT OF BARLEY SEEDS. Haensel, Hermann (Hochschule fuer Bodenkultur, Vienna). Bodenkultur, 16: 325-39(Nov. 1965). (In German).

The rates and spectra of ethyl methane sulfonate (EMS)-, neutron-, and x-ray-induced chlorophyll mutations in barley are presented. After 1.5% EMS treatment the percentage of M_2 mutant seedlings was about ten times and after neutron irradiation (10,000 R) about three times as high as after x irradiation (12,000 R). With increasing concentrations of EMS (0.5 to 1.8%), a relative increase of completely sterile M_1 plants (9 to 91%), of mutant M_1 plants (16 to 60%), of M_2 mutant seedlings (1 to 13%), and of mutant seedlings within segregating M_2 lines (7 to 23%) was observed. When seeds were soaked for five or 12 hr and dried at 35°C to give a water content of about 12.5%, then stored for six months at room temperature and finally irradiated by 12,000 R doses of x rays, the induced mutation rate was about twice the rate of the control seeds, stored and irradiated without such pretreatment. The pretreatment itself had no significant effect on the mutation rate. When the M_2 plants of EMS-treated seeds were grown in the field, the ratio viridis/albina mutants was higher than when they were grown in a hothouse. After EMS seed treatment about 11% of the mutant M_1 plants segregated for more than one chlorophyll mutation. If different mutations were induced in different surviving germinal cells of the same embryo and subsequently transferred in different ears or ear sectors of the same M_1 plant, no disadvantage for mutant selection was expected. If more than one mutation was induced in the same embryonic germinal cell, the M_2 genotype homozygous for a positive mutation could be loaded with additional mutant alleles of a small negative effect. It was estimated that after a high-dosage EMS treatment more or less all the surviving germinal cells should be heterozygous for two or more mutations. If this were true, the mutants selected in M_2 or M_3 should be submitted to laborious pedigree breeding for the purpose of producing and recognizing positive mutant genotype free of negative mutant genes. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 14905, 14916, 14937, 14942, 14943, 14995, 15042, 15062, 15125, and 15128.

15120 THE EFFECT OF X-IRRADIATION ON THE INHIBITORY ACTIVITY OF DNA IN EXPERIMENTS ON THE TRANSFORMATION OF B. SUBTILIS. Stolyarova, L. G.; Usakovskaya, T. S.; Golubeva, G. P.; Pekhov, A. P.; Tseitlin, P. I. (Inst. of Experimental Biology, Moscow). Radiobiologiya, 7: 516-8(1967). (In Russian).

Deoxyribonucleic acid was separated from the strain B. subtilis 2ZEMB. The recipient was B. subtilis 168-2 leu$^-$try$^-$. The sources of the inhibiting DNA were cells of B. subtilis 168-2 leu$^-$try$^-$; E. coli W-945 F$^-$thr$^-$leu$^-$B$_1^-$, lac$^-$S^s; E. coli J-62 F pro$^-$try$^-$his$^-$ lac$^-$S^r and calf thymus. All samples of DNA were tested and found capable of sharply inhibiting the transformation of B. subtilis. Before being introduced into the transformation mixture they received doses of 5, 10, 20, 30, 50, 75 and 100 kR. The radiation influenced the inhibiting activity of the DNA; with increasing dose the inhibiting activity decreased, and at 100 kR the quantity of leu$^+$, try$^+$ and leu$^+$try$^+$ transformants became equal to that of similar transformants obtained in the absence of inhibiting DNA. The dose dependence of the inhibiting activity is linear. (JPRS)

15121 THE EFFECT OF ULTRAVIOLET RADIATION UPON OSMOREGULATION IN PARAMECIUM. Saier, F. L.; Giese, A. C. (Stanford Univ., Calif.). Photochem. Photobiol., 6: 745-55(Oct. 1967).

Paramecium multimicronucleatum was uv irradiated in solutions of differing osmotic pressures and ionic content. The rates of contraction and the diameters of the anterior contractile vacuoles were measured, and changes in the volumes of solution entering the contractile vacuoles upon uv irradiation for paramecia maintained in solutions of differing ionic content were calculated. The volume of fluid entering the contractile vacuoles of paramecia

irradiated in standard balanced salt solution (SBSS) was regulated by a compensatory mechanism at lower uv doses but increased after relatively large uv doses; in distilled water, increased after much smaller uv doses; in isotonic balanced salt solution, showed little change following irradiation. Increased osmotic pressure (with added sucrose) reduced uv-induced blistering of the pellicle, but, in general, uv damage was similar to that of paramecia in solutions of identical ionic content but lacking sucrose. Paramecia in SBSS with added sucrose to make it isosmotic to the interior of the cell ruptured only after doses larger than for paramecia in SBSS lacking sucrose. Cell rupture of paramecia in solutions containing high $CaCl_2$ concentrations generally occurred later than for those in SBSS. High KCl concentration (unbalanced salt solution) in the presence of high $CaCl_2$ concentration provided some protection from uv irradiation to the paramecia. High NaCl concentration (unbalanced salt solution) in the presence of high $CaCl_2$ concentration increased uv damage to paramecia. Paramecia were most resistant to uv irradiation when in balanced salt solution enriched with Ca thus simulating pond water. (BBB)

15122 EFFECT OF IRRADIATED GLUCOSE SOLUTION ON PHAGE AND INFUSORIA. Popov, A. S.; Vinetskii, Yu. P. (Inst. of Biophysics, Moscow). Radiobiologiya, 7: 630-1(1967). (In Russian).

Phages T2 and T4 and a clone of Paramecium caudatum were placed in gamma-irradiated peptone-free Lozina–Lozinskii and M-9 solutions respectively at various temperatures and their inactivation was determined at intervals. The results showed that the presence of glucose in the medium resulted in toxity, evidently by increasing the yield of hydrogen peroxide, but the possibility of the action of other peroxides is not excluded. (JPRS)

15123 RECOVERY OF DIVISION ABILITY IN ULTRAVIOLET-IRRADIATED ESCHERICHIA COLI INDUCED BY PHOTOREACTIVATION, PHOTOPROTECTION, AND LIQUID HOLDING TREATMENT. Kantor, George J.; Deering, R. A. (Pennsylvania State Univ., University Park). J. Bacteriol., 94: 1946-50(Dec. 1967).

Small doses of ultraviolet light (uv, 265 mμ) cause Escherichia coli B to grow into long, multinucleate, nonseptate, filamentous cells. This uv-induced filament formation can be prevented by irradiating with photoprotecting light (335 mμ) prior to uv irradiation, and by irradiating with photoreactivating light (406 mμ), or by liquid holding treatment, after uv irradiation. It is concluded that uv-induced division inhibition in E. coli B is initially induced by repairable lesions in the deoxyribonucleic acid, probably pyrimidine dimers. (auth)

15124 INACTIVATION OF VENEZUELAN EQUINE ENCEPHALOMEYELITIS VIRUS BY γ-RADIATION. Reitman, Morton; Tribble, Henry R. Jr. (Medical Sciences Lab., Fort Detrick, Frederick, Md.). Appl. Microbiol., 15: 1456-9(Nov. 1967).

Exposure of Venezuelan equine encephalomyelitis (VEE) virus (at –70 C) to 6×10^6 R γ-radiation (^{60}Co) resulted in loss of lethality for young adult mice and guinea pigs, and loss of capacity to produce plaques or cytopathic effects in tissue culture. The suckling mouse was more sensitive for detecting live virus in radiated suspensions than was the adult mouse or guinea pig. Live virus was demonstrable in preparations exposed to 6×10^6 R but not in suspensions exposed to 8×10^6 R and more. The rate of inactivation of VEE virus by γ-radiation was an exponential function of the dosage. (auth)

Radiosterilization and Radiopreservation

15125 (RLO–1730-2) IRRADIATION PASTEURIZATION OF SEAFOODS. Annual Progress Report, October 1, 1966–September 30, 1967. Liston, J.; Matches, J. R. (Washington Univ., Seattle. Coll. of Fisheries). Contract AT(45-1)-1730. 55p. Dep. CFSTI.

English sole fillets and crab meat were inoculated with Salmonellae, and outgrowth of the organisms was determined before and after γ irradiation, and during subsequent storage. Salmonellae were found to grow competitively in English sole tissue at temperatures as low as 8°C in inocula as low as ten cells per gram, but they grew in non-sterile crab tissue only at temperatures higher than 11°C. Irradiation facilitated Salmonella growth at low temperatures in English sole and at 22°C in crab meat by reducing the competitive microflora. Irradiation has no effect on minimum growth temperatures and Salmonella growth was not obtained in seafood under any condition at temperatures below 6°C. Low dose and double dose studies were conducted on English sole. Whole fish in polyethylene bags were irradiated at 50 Krad, stored at 1°C for seven days, filleted, and a portion of the fillets packaged in polymylar pouches exposed to a second dose of 100 Krads prior to storage at 1°C. Fillets were prepared also from fresh fish and given single dose (50 Krad) and double dose (50 + 100 Krad) treatment. Fillets from the non-irradiated fish had a total shelf life of about 12 days, fillets from 50 Krad treated whole fish about 18 days, single dose fresh fillets about 18 days, fillets from 50 Krad fish + 100 Krad about 18 to 22 days, and double dose fillets (50 + 100 Krad) greater than 28 days. Total volatile base (TVB), trimethylamine (TMA), and tyrosine N (for proteolysis) assays were conducted on double irradiated fish and indicated that the double dose treatment further depressed TMA and TVB production. There was a marked depression of tyrosine N increase in double irradiated fish as compared with non-irradiated or single irradiated (about 30, 20, and 15 mg tyrosine N per 100 g fish for 0, 50 Krad and 50 + 100 Krad fish respectively after 20 to 25 days' storage). This indicates suppression of bacterial proteolysis that occurs during late spoilage in untreated fish. Direct proteolytic counts confirmed that 50 Krad reduced proteolytic bacteria to very low levels, while 50 + 100 Krad virtually eliminated them. Biochemical analysis of bacterial populations revealed rapid development of an active TVB producing population on untreated fillets and a slower development on the irradiated fillets. Recovery of Staphylococcus aureus damaged by sublethal radiation was investigated using specific inhibitors of DNA, RNA, and protein synthesis. Tracer studies on uracil and thymidine uptake were also used in recovery studies. Repair was shown to occur optimally at 37°C and a pH of 5.5 and appeared to involve DNA synthesis, protein, and RNA synthesis with a consequent energy requirement. It was noted that cells recovering from radiation damage were hypersensitive to a second exposure to radiation and to heat shock during the repair period. Results of all studies are shown by means of tables and graphs. (H.L.W.)

15126 IRRADIATION OF FOOD. Roy. Soc. Health J., 86: 251(Sept.-Oct. 1966).

The policy of the Ministry of Health of the United Kingdom regarding radiation preservation of food products is discussed. The Ministry has promulgated regulations that appear to place a complete ban on the irradiation of food and food products intended for human consumption and on the sale in the United Kingdom of food subjected to irradiation. Currently no food irradiated to prolong storage life was offered for sale in the UK. In the regulations, irradiation was carefully defined and included radiation produced from radioactive sources of both corpuscular and electromagnetic wave form (γ rays), x radiation, and fast electrons. Provision was made, however, for the use of low density ionizing radiations such as were used in nucleonic scanning devices for ensuring that food packets were filled and their contents of consistent size. To what extent biological and chemical changes in irradiated foods were hazardous was considered in terms of findings of the Report of the Working Party on Irradiation of Foods (1964). The view expressed therein was that the health hazards were on examination negligible, provided food was irradiated under controlled conditions. Dose levels were clearly important and the recommendation was made that rigid definition of procedures would be needed to ensure that hazards were reduced to small proportions. Secondly it was stated that though treatment with ionizing radiations might produce alien odors and flavors, nutrient destruction approximated that of cooking the same foods, as there was a mutually protective action within a food that considerably reduced the irradiation effect on each separate constituent, e.g., vitamins. Macronutrients, i.e., proteins, fats, and carbohydrates, were altered little by irradiation in terms of nutrient value and digestibility. The possible survival of Clostridium welchii and more particularly Clostridium botulinum spores, in small numbers, might create problems if irradiated foods were stored for unduly long periods in diminished aerobic and acidic conditions. However, mild heat treatment might involve similar hazards. Although the ban on irradiation was at present total, there might be cases where radiation sterilization could be permitted when enough was known on the many aspects involved that appeared to concern less the dangers of irradiation than conditions of microbial survival. (BBB)

15127 STERILIZATION BY ULTRAVIOLET RADIATION AND ITS SIGNIFICANCE FOR MEDICAL AND PHARMACEUTICAL PRACTICE. Oberdoerster, Friedrich (Humboldt Univ., Berlin). Wiss. Z. Humboldt Univ. Berlin, Math-Naturwiss. Reihe, 16: 191-3(1967). (In German).

In the uv range below 280 nm the maximum of the sp microbicidal effect was located between 250 to 270 nm. The quantitative irradiation effects observed were compatible with the collision theory, where the lethal effect followed the statistical laws of probability, producing an S-shaped curve of effectivity. The smallest amount of irradiation could kill a few organisms, but even the largest doses would not destroy all of the organisms

present. The number of quanta required to kill an organism could be one, three, or more, depending on the resistance of the organism. Various vegetative types of bacteria differed in their sensitivity to uv irradiation only slightly. Spores of bacteria and molds had a resistance to uv irradiation ~10-fold greater. Because of the collision type of effects, complete sterilizations by uv radiations were impossible, but since the uv effect could be as high as 90%, uv irradiation sterilization frequently was practical. Generally, a low pressure Hg uv source was used since it absorbed most of the radiation below 250 nm, resulting in less ozone formation. (BBB)

15128 MICROBIOLOGICAL ASPECTS OF RADIATION STERILIZATION. Bridges, B. A. (Atomic Energy Research Establishment, Harwell, Eng.). Progr. Ind. Microbiol., 5: 283-326(1964).

The following topics are reviewed: effects of ionizing radiations on micro-organisms (historical survey, physiological effects, lethal effects, survival curves, comparative sensitivity); mechanism of action (absorption of energy by the cell, site of cellular damage); factors modifying radiation damage (type of radiation, effect of dose rate, the oxygen effect, protective agents, sensitizing agents, water content, freezing, effect of conditions after irradiation); the sterilizing dose (traditional method, probability method); and use of substerilizing doses of radiation (extension of shelf-life, combined processes, elimination of specific pathogens). Sterilization by ionizing radiation was considered initially for application to the preservation of food. Although many drawbacks have so far prevented its general adoption, with the possible exception of food for animal consumption, the technique still holds some promise. The use of radiation to sterilize medical and pharmaceutical products has, in contrast, developed rapidly. Applications include the sterilization of vaccines, antisera, biological tissues (e.g., arterial and bone grafts), pharmaceuticals, plastic items (e.g., arterial and mammary prostheses, catheters, disposable hypodermic syringes), and other hospital equipment (e.g., rubber gloves, surgical sutures and blades, packaging and wrapping materials). Many of these items are regularly being sterilized by radiation (mostly ^{60}Co γ radiation) on a commercial scale. 184 references. (BBB)

15129 RESPONSE OF THE PHENOMENA OF EXTRACT-RELEASE VOLUME AND WATER-HOLDING CAPACITY TO IRRADIATED BEEF. Jay, James M. (Wayne State Univ., Detroit). J. Food Sci., 32: 371-2(July-Aug. 1967).

The extract-release volume (ERV) of meats is a measure of their capacity to release varying volumes of extract from meat homogenates. A measure of water-holding capacity (WHC) of meats by the filter-paper press method gives results similar to those obtained by the ERV method, and the two methods respond essentially the same to beef spoilage. In the course of determining the effect of irradiation on ERV and WHC, a difference was noted between these two techniques. Single beef muscles were ground and subjected to varying doses of ^{60}Co γ irradiation. The effects of irradiation on ERV and WHC employing semimembranous muscle were determined. With respect to ERV, as the dose of irradiation increased from 0.3 to 2.4 Mrad, ERV increased by ~40%. After 30 days at 5°C, ERV increased by 99.5% on the same samples with increasing radiation dose. Immediately after irradiation, WHC decreased (increase of free-water area) with increasing dose to ~13%. However, after 30 days the percentage of WHC was only seven compared to around 99.5 for ERV under similar conditions. The basis for this smaller change in WHC is shown by the size of pressed meat-film areas from 500-mg samples. Immediately after irradiation, the average meat film area was 1.63 $in.^2$ while only 1.41 $in.^2$ 30 days later at 5°C. As the dose of irradiation increased, size of meat-film area decreased both immediately after irradiation and 30 days later. The smaller change in WHC both with increasing doses and time of incubation was a consequence of shrinkage of meat-film area, giving more intense wetting of the filter paper near the meat film and consequently less spreading of the free water. The shrinkage was attributed to polymerization as a result of cross-linking within meat proteins. (BBB)

15130 GAS EXCHANGE IN BARTLETT PEARS IN RELATION TO GAMMA IRRADIATION. Bussel, Joseph; Maxie, E. C. (Univ. of California, Davis). Proc. Amer. Soc. Hort. Sci., 88: 151-9(1966).

The rate of gas exchange was studied in Bartlett pears (Pyrus communis). Movement of O_2 into or from the internal atmosphere was very rapid, and was not severely restricted as the fruits ripened. Irradiation with 300 krad of γ rays and a temperature of 86°F stimulated production of C_2H_4. Flushing the fruit with N_2 inhibited production of C_2H_4. When anoxic fruits were transferred to air, production of C_2H_4 during the 42 min of the experiment was resumed only in the irradiated pears. Production of C_2H_4 at different stages of the climacteric was inhibited when the pears were transferred to N_2, and was renewed upon their return to air. Because of the rapid gas exchange in Bartlett pears, it is impractical to irradiate the fruit immediately after transfer from N_2 to air in the hope of protecting the fruit from radiation injury. (BBB)

15131 AN INTERNATIONAL PROJECT OF RESEARCH ON THE IRRADIATION OF FRUIT JUICES. Dupuy, P. (Institut National de la Recherche Agronomique, Dijon, France). Cah. Ing. Agron., 209: 21-5(Oct. 1966). (In French).

The origin of the program in 1964 is reviewed. Justification for the project was made in technological and nutritional terms. The installation for ^{60}Co irradiation studies at Seibersdorf was described briefly. Organization of research was outlined. Research programs included fruit juice irradiation and combination of the technique with others. Practical and theoretical aspects of inactivation of microorganisms were studied, as was the inocuousness of irradiated juices fed to animals. Special tests to determine the extent of modification in the survival of microorganisms were in progress. Moderate heating (50°C) and irradiation (150 Krad) had a synergistic effect; this observation could open a new route for the sensitization of microorganisms towards radiation. No unexpected difficulties were noted after 18 months although the practical future of fruit juice irradiation was not established. (BBB)

15132 EFFECT OF GAMMA IRRADIATION ON RIPENING AND QUALITY OF NECTARINES AND PEACHES. Maxie, E. C.; Johnson, Carol F.; Boyd, Camilla; Rae, Henry L.; Sommer, N. F. (Univ. of California, Davis). Contract UCD-34P80. Proc. Amer. Soc. Hort. Sci., 89: 91-9(1966).

Freestone peaches and nectarines (Prunus persica), climacteric-type fruits, were studied to clarify the effects of γ irradiation on ripening. Investigations were conducted to evaluate the effects of ^{60}Co γ irradiation on respiratory rate, C_2H_4 evolution, ripening, anthocyanin content, and quality attributes of nectarines and peach peaches. Doses of 100 to 600 krad initiated the climacteric and ripening sequence in both nectarines and peaches, apparently by inducing the unripe fruits to produce stimulatory amounts of ethylene (C_2H_4). Rates of CO_2 and C_2H_4 production were much higher in irradiated than in unirradiated fruits at every stage of the climacteric sequence, and irradiated fruits ripened 4 to 5 days earlier. Irradiated fruits were noticeably redder than unirradiated ones. The skin and flesh of irradiated Elberta and Suncrest #72 peaches contained more anthocyanin than unirradiated fruits. Irradiated nectarines were acceptable for flavor and appearance, but aroma and texture were poor. Loss of flesh firmness in irradiated fruits made them so susceptible to mechanical injury that irradiation as a protective technology for these fruits is precluded. (BBB)

15133 MODERN METHODS FOR STERILIZATION OF CATGUT. Hudemann, Harald (Institut fuer Medizinische Mikrobiologie und Epidemiologie, Magdeburg, Ger.). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe, 16: 225-8(1967). (In German).

Sterilization of catgut using fast-electron-irradiation is reviewed. The adequate dose and the advantages of this method over heat sterilization were discussed. (BBB) (TSS)

15134 FOOD HYGIENE AND IONIZING RADIATION. Morre, J. (Laboratoire de Radiobiologie, Paris). Rev. Hyg. Med. Soc., 13: 257-78(1965). (In French).

Interrelations between foodstuffs and ionizing radiation are discussed in two categories: the role of fallout radionuclides on human health, and radiation preservation of food. The possible effects of ^{90}Sr and ^{137}Cs as well as other less hazardous radiocontamination are examined. A comparison is made between alimentary introduction of artificial radioelements into the mammalian system (90%) and respiratory penetration (only 10%). In some instances, leukemia was attributed to ^{90}Sr deposition in bone. Preservation of foods by irradiation is discussed. The use of ^{60}Co γ radiation, along with current techniques and safe doses, is presented, particularly with reference to irradiation of vegetable products, fruits, cereals, and potatoes. A mobile ^{60}Co irradiator currently in use is described. Irradiation after freezing of fish is considered in terms of current experiments, flavor changes, bacteriology, and safety. Irradiation of meat and meat products is considered, especially in the destruction of parasites. Irradiation of eggs and milk are also discussed. It was concluded that methods must yet be developed to utilize the advantages of radiation preservation while still eliminating undesirable results such as changes in odor, color, and flavor of various food products. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 14724.

15135 (IN-1133) THE DEVELOPMENT OF POWDERED URANIUM-ALUMINIDE COMPOUNDS FOR USE AS NUCLEAR REACTOR FUELS. Gibson, G. W. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 82p. Dep. CFSTI.

The use of uranium-aluminide powders in dispersion-type, aluminium-clad fuel elements was investigated. Fuel plates, made by powder metallurgical techniques using these powders, have been fabricated and tested under a variety of conditions. These tests have shown this approach to be satisfactory and advantageous for use in the preparation of fuel elements for high-flux, high-power-density nuclear reactors. (auth)

15136 (ANL-Trans-559) ISOTOPE EXCHANGE OF Fe IN THE TWO-PHASE SYSTEM SOLID METAL-LIQUID SLAG. Khan, Chi-yun; Grigoryan, V. A.; Zhukhovitskii, A. A. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Izv. Vyssh. Ucheb. Zaved., Chern. Met., 4: No. 5, 5-16(1961). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A method was developed which permits a study of transfer processes of components in a two-phase system under conditions of controlled convection. It was shown that the study of the exchange of iron between the metal and the liquid melt of oxides under the indicated conditions permits a determination of the diffusion characteristic in both phases. A theory for the transfer in a two-phase system is given and a method for a "comparison" of kinetic curves with dimensionless graphs was developed which obtains the diffusion coefficients of the component in both phases in one experiment. The exchange rate of iron between the solid sample and the liquid melts of oxides was studied at three temperatures and for different numbers of revolutions. It was found that there exists a linear dependence of the external diffusion flux on the square root of the number of revolutions. The diffusion coefficients of iron in the slag were determined for three temperatures. (auth)

15137 NUCLEAR REACTOR MATERIALS. Smith, Charles O. Addison-Wesley Series in Metallurgy and Materials Science. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1967. 270p. $13.50.

An in-depth survey of materials requirements and usage in nuclear reactors is presented in the nuclear engineering book. Content areas include the role and requirements of materials in nuclear reactors, materials in fuel elements and liquid-fuel reactors, effects of nuclear radiation, characteristics of specific materials (such as uranium, plutonium, thorium, structural metals, ceramics, and graphite), and materials development. The logical development of the role of materials in reactors is followed. Helpful problems and exercises are provided. (J.C.W.)

Corrosion and Erosion

Refer also to abstracts 14470 and 14471.

15138 (AWRE-O-9/65) URANIUM COMPATIBILITY STUDIES. PART 4. THE CORROSION OF URANIUM IN HYDROGEN PEROXIDE SOLUTIONS. Baker, M. McD.; Less, L. N.; Orman, S. (Atomic Weapons Research Establishment, Aldermaston (England)). Apr. 1965. 11p. Dep. CFSTI. UK.

It was found that dilute H_2O_2 solutions corrode uranium, at room temperature, very much more rapidly than pure water. The rate is a maximum at approximately 12 mole % H_2O_2, and is very slow in highly concentrated solutions. The product is yellow hydrated uranium peroxide. (auth) (UK)

15139 (AWRE-R-3/63) PHYSICO-CHEMICAL STUDIES OF FUSED SALT SYSTEMS. PART 6. CORROSION OF CERTAIN METALS CAUSED BY THE FUSED SODIUM FLUORIDE-URANIUM TETRAFLUORIDE EUTECTIC. Baker, M. McD.; Jones, P. M. S.; Ridgway, Sheila P. (Atomic Weapons Research Establishment, Aldermaston (England)). July 1963. 38p. Dep. CFSTI. UK.

Experimental work is described which leads to the conclusion that hydrogen fluoride is not the major corrosive agent in these systems; the evidence suggests that some hydrolysis product of uranium tetrafluoride, such as uranyl fluoride, is responsible for the observed corrosion of metals. Gas evolution from the eutectic in metal containers is due almost entirely to the presence of sorbed gases. Little or none is due to chemical reaction. The likelihood of corrosion by uranyl fluoride, uranium tetrafluoride, sodium fluoride, and hydrogen fluoride is considered theoretically. The thermodynamics of uranyl fluoride attack on metals indicate that it may well be the main corrosive agent present in the fused eutectic. The theoretical and experimental resistances of container materials to corrosion are in good agreement. (auth) (UK)

15140 (BMI-X-489) CORROSION RESISTANCE OF NICKEL AND TWO NICKEL ALLOYS TO GASEOUS BROMINE. Miller, Paul D.; Stephan, Elmer F.; Berry, Warren E.; Boyd, Walter K. (Battelle Memorial Inst., Columbus, Ohio). Jan. 4, 1968. Contract W-7405-eng-92. 12p. Dep. CFSTI.

Bromine is formed when U_3O_8 is reacted with BrF_5 in the Fluidized-Bed Fluoride Volatility method of processing certain spent nuclear fuels. In support of development work on this process the corrosivity of gaseous bromine on plant construction materials was studied. Review of the literature showed that nickel and Monel are quite resistant to liquid bromine at ambient temperatures, provided the moisture content is low. Experimental work involving exposures in gaseous bromine at 300 and 500°C showed that coupon specimens of Nickel 201, Duranickel 301, and Huyck Feltmetal were much more resistant than Monel. The penetration rate on Monel was about 5 mils per month at 300°C, whereas the attack on the other nickel-base materials was negligible. At 500°C penetration rates of the order of 0.5 mil per month were measured for Nickel 201 and Duranickel 301. Some intergranular attack was also detected. Welded specimens behaved in the same manner. The presence of oxygen in the bromine at 300°C did not significantly affect corrosion behavior. Selective attack occurred on some areas of the Nickel 201 and Duranickel 301 specimens when Monel specimens were also in the system. It is believed that the attack was associated with the deposition of bromide salts formed when bromine reacted with the constituents in Monel, particularly copper. Copper specimens were rapidly attacked. (auth)

15141 (BNL-50057, pp 79-100) NUCLEAR ENGINEERING. (Brookhaven National Lab., Upton, N. Y.).

Efforts devoted to basic research on reactor physics, chemistry, and metallurgy are reported along with descriptions of long range work designed to bring about significant advances in reactor technology. Engineering and evaluation studies focused on practical applications of basic research are also described. (J.R.D.)

15142 (DUN-SA-45) CHEMICAL CLEANING OF THE N REACTOR SECONDARY PIPING. Jensen, H. F. (Douglas United Nuclear, Inc., Richland, Wash.). Feb. 2, 1968. Contract AT(45-1)-1857. 9p. (CONF-680204-1). Dep. CFSTI.

From American Institute of Chemical Engineers Society Meeting, Corvallis, Ore.

N Reactor, the world's largest nuclear steam plant, uses carbon steel piping in most of its primary and secondary heat exchange systems. Sandblasted, etched, and inhibited piping was used exclusively in the primary system. The secondary system was constructed with conventional practices to reduce costs. This type construction required a post construction flush and chemical cleaning prior to reactor startup. Normal industrial practice in chemical cleaning specifies a sequence of chemical treatments to remove protective varnishes, rust, and millscale with thorough water flushes interspersed to insure removal of the preceding chemical solution. A final passivating or inhibiting treatment is specified when the system is not to be used immediately following the cleaning. The complexity of the N Reactor's secondary piping system indicated this multiple step approach would be costly and difficult to accomplish with completely satisfactory results. A procedure is described by which the chemical cleaning of the secondary system was accomplished with excellent results. The final cost accounting showed less than 10 percent of an earlier estimate expended in this effort. (J.C.W.)

15143 (GEMP-1002, pp 123-36) PHYSICO-CHEMICAL STUDIES OF CLAD UO_2 IN POTENTIAL MELTDOWN ENVIRONMENTS. White, J. F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The temperature of failure of Zircaloy-4 cladding material was determined for sheet stock in plastic deformation at constant sample loading and for tubes at constant internal pressure, both at several constant rates of temperature increase. The temperature of failure (i.e., 34% expansion for the tubes, and rupture for the tensile specimens) was found to be heating-rate sensitive with higher failure temperatures occurring at higher heating rates. Analysis of the data from constant-pressure tube tests and constant-load tensile tests to determine the relationship between the

applied stress, the heating rate, the total strain at failure and temperature of failure may be represented by an equation. The activation energy for second-stage creep Zircaloy-4 obtained from these data is 78 kcal/mole, which is close to the expected value of 81 kcal. At a steam flow rate of 3.4 standard liters/min, no trend in oxide thickness variation was observed between top and bottom ends of 50-cm-long simulated fuel elements. Extension of experiments on the steam-oxidation of $UO_{2.002}$ to 1830°C show that the oxygen diffusion coefficient in hyperstoichiometric UO_2 may also be represented by an equation for the temperature range 885 to 1830°C. The diffusion mechanism was validated by the measurement of an oxygen gradient within a sample. A least squares fit to the data for oxidation of Zircaloy-4 at temperatures above 1600°C along with that of Baker yields a mathematical expression. (J.C.W.)

15144 (GEMP-1002, pp 137-42) HIGH-TEMPERATURE THERMOCOUPLE AND ELECTRICAL MATERIALS RESEARCH. Funston, E. S.; Kuhlman, W. C. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Studies revealed that bare thermocouple wires at high temperature can be affected by thermionic currents flowing between furnace parts; this effect is a function of the gas medium (helium, argon, or hydrogen). A study of $CaHfO_3$, $SrZrO_3$, and $SrHfO_3$ as thermocouple insulators revealed that $SrHfO_3$ performed the best. $SrHfO_3$, however, is less resistant than BeO, but it may have a higher usable temperature limit due to its higher melting point. (auth)

15145 (WAPD-T-1977) TESTING AND SELECTION OF MATERIALS FOR WEAR APPLICATIONS IN HIGH PURITY WATER. Dewees, N. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1967. Contract AT-11-1-GEN-14. 22p. Dep. CFSTI.

The essential differences between testing in pure research and testing for specific applications are described. Problems encountered in testing for wear applications in high purity water are discussed. These problems relate primarily to variability of results, response to changes in test parameters, and degree of simulation. Corrosion influences are briefly mentioned. Interpretation of existing data in the light of these problems is also discussed. The significance of wear test results falling into different characteristic patterns is shown. Precautions which must be observed in planning and conducting a wear test program and in interpreting wear test data are presented. (auth)

15146 (EURFNR-374) OXIDATION OF VANADIUM-TITANIUM AND VANADIUM-TITATNIUM-NIOBIUM ALLOYS BY SODIUM CONTAINING SODIUM OXIDE, IN 500-700°C TEMPERATURE RANGE. Borgstedt, Hans Ulrich; Drechsler, Guenther; Frees, Guenter; Huenlich, Arnold (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report PSB-257/67. 27p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Corrosion-behavior tests were made in static and dynamic sodium plants on a number of vanadium-base alloys, containing titanium or titanium and niobium, which had been melted and processed to plates as part of fuel clad material development. Corrosion behavior is determined primarily by the sodium oxide content of the corrosion medium; slight differences are induced by temperature variations, alloy composition and sodium flow. Oxide coats form on all specimens in sodium containing more than 10 to 12 ppM oxygen or thereabouts. Specimen weight loss varies with temperature and alloy composition; it is about 3 to 6 mg/cm^2 at 600°C (in 520 hours). Corrosion rates increase as niobium content rises and titanium content declines. Slight (positive) weight changes occur in static sodium with low oxygen contents achieved by hot-trap cleaning. In this case the specimens have a metallic appearance. Metallographic inspection shows that, in addition to corrosion damage visible from the outside, all specimens have internal embrittlement zones whose penetration depth is influenced by alloy composition and sodium oxide content. This embrittlement can spread throughout a specimen cross-section in 500 hours but is limited to narrow peripheral zones if the alloy contains enough of a constituent acting as a sort of oxygen barrier. In a certain sense, more than 5% titanium satisfies the requisites for restricting embrittlement to the periphery. (auth)

15147 INFLUENCE OF SURFACE PREPARATION AND FLUORINE CONTAMINATION ON THE CORROSION OF ZIRCALOY-2 IN WATER AND STEAM. Sietnieks, A.; Ostberg, G. (Aktiebolaget Atomenergi, Stockholm). Brit. Corros. J., 3: 7-11(Jan. 1968).

Corrosion experiments in autoclaves and in the Ågesta reactor were made on Zircaloy-2 with surface treatments, such as pickling, pickling and electropolishing, or electropolishing only. The autoclave experiments were carried out at 250°C (water, 4 years), 300°C (water, 3 years), 350°C (water and steam, 240 days), and 400°C (steam, 432 days). The weight-gain and hydrogen absorption agreed with previously reported figures, the major effect of surface treatment being a higher initial corrosion rate for pickled specimens than for pickled and electropolished specimens. Measurements of impedance and true surface area on material with different surface treatments did not show any correlation with the differences in corrosion rate. Determination of the amount of fluorine on the surface and in the oxide yielded higher values for the pickled material, and results agreed with previous experience of an accelerating effect of fluorine. The fluorine gradient in the oxide followed a simple diffusion function. (auth) (UK)

15148 GROWTH OF AUSTENITIC STAINLESS STEELS OXIDISED IN CARBON AND OXYGEN BEARING GASES. Noden, J. D.; Knights, C. J.; Thomas, M. W. (Central Electricity Generating Board, Berkeley, Eng.). Brit. Corros. J., 3: 47-55(Jan. 1968).

Sample lengths from Advanced Gas Cooled Reactor were fuel cans in 20Cr/25Ni/Nb and 18Cr/12Ni/Nb steels, and specimens of thin 18Cr/8Ni/Ti foil were heated in carbon dioxide and other oxidizing gases at 750 to 900° for periods up to 2500 hr. Length increases of up to approximately 2% were observed, the growth being greater under conditions of thermal cycling than under isothermal conditions. Extensions were related in part to carbon pick-up, and the formation of carbides, but the major proportion of the observed extensions was due to tensile stresses produced in the thin sectioned steels as a result of the oxidation processes. (auth)

15149 MASS TRANSFER PHENOMENA CAUSED BY LIQUID SODIUM AT NICKEL AND MOLYBDENUM ALLOYS. Borgstedt, H. U.; Heim, W. Werkst. Korros., 18: 311-16(Apr. 1967). (In German).

As a phenomenon of liquid metal corrosion, an isotherm mass transfer takes place via the liquid phase in systems where austenitic high-tensile steels are in contact via liquid Na with Ni or Mo alloys. On specimens of such alloys, microcrystalline segregations are observed as a result of such mass transfer. Most of the minute crystals, measuring between 10^{-3} and 10^{-2} mm, have grown at grain boundaries. Microprobes have shown that these crystals are enriched with Fe. The atom ratios are Fe : Mo = 1 : 1 (7 : 6) or Fe : Ni = 2 : 1 on Incoloy 800, and 6 : 1 to 10 : 1 on Incoloy 626. Chromium and other steel components are of less importance in the microcrystals. The Fe, enriched in the segregations, originates from the Fe-rich steel. (Rev. Metal Lit.)

15150 INVESTMENT CAST BLADES WITHSTAND 1900°F. Precis. Metal Molding, 25: No. 8, 41(Aug. 1967).

High-strength B-1900 Ni-Ta alloy, containing only 1% Ti, less than 1% W and 4% Ta, is used in investment cast turbine blades of aircraft jet engines. With a spray coating of Al and Si, B-1900 blades survived corrosion testing at temperatures up to 2100°F for longer periods than any other Ni-base alloy. Creep and rupture tests of the blades at up to 2000°F show less stretch and greater resistance to cracking under extreme temperature variations than blades of other alloys. (Rev. Metal Lit.)

15151 ELECTRON MICROSCOPIC OBSERVATION OF OXIDIZED ZIRCONIUM FILM. Missiroli, G. F. (Univ. of Bologna). J. Nucl. Mater., 25: 93-6(1968).

Observations on zirconia films on reactor-grade Kroll zirconium at 300 to 500°C are reported. Films grown on polished surfaces in dry oxygen at 400°C were characterized by: monocrystalline structure, spot-like inhomogeneities inside the grain, grain boundaries that appear more marked than the grains, and an absence of defects except for small holes that may be due to impurities in the zirconium matrix. Other films contained many defects. (M.C.G.)

15152 CORROSION BEHAVIOR OF VARIOUS RARE METALS IN AQUEOUS ACID SOLUTIONS, WITH SPECIAL CONSIDERATION OF NIOBIUM AND TANTALUM. Bohni, H. (Eidgenoessische Technische Hochschule, Dubendorf, Switzerland). Schweiz. Arch. Angew. Wiss. Tech., 33: 339-63(Nov. 1967). (In German).

A comparative study was made of the corrosion behavior of Ti, Zr, V, Nb, Ta, Mo, and W in aqueous solutions of inorganic acid, and the results were compared with results obtained with stainless austenitic Cr-Ni steel. Electrochemical methods were used for the qualitative and quantitative evaluation of the corrosion behavior. The applicability and utility of the study methods used were also evaluated. The corrosion behavior of Nb and W was studied extensively with emphasis on the embrittlement phenomena. In Hf and other nonoxidizing dilute acids Zr, V, Nb, Ta, Mo, and W showed no corrosion but Ti was attacked as Cr-Ni stainless

steel. In oxidizing acids, Mo and V were not stable since they, at higher potential, formed no passivation coatings. All the other metals including austenitic Cr–Ni steel were passivated by these acids. In diluted acid solutions containing aqueous HF the metals were more or less attacked according to their place in the periodic system. Ta and Nb are not corroded in HF-free acid solutions. Ta was less sensitive than Nb in HF solutions. The inclination to hydrogen embrittlement is approximately of the same magnitude of both Ta and Nb. The hydrogen deposited in the metal leads to an expansion of the metal lattice. The current density/potential curves obtained by potentiodynamic operation were found to be well suited for the qualitative evaluation of corrosion behavior. The possibility of making assumptions on the behavior in other corrosive materials if the cathode partial reactions are known is shown. The stationary electrochemical behavior must be known for quantitative evaluation of corrosion behavior. Determination of the corrosion velocity by polarization resistance permits a quantitative determination of the corrosion in the unpolarized state. The accuracy of this method is satisfactory for corrosion testing. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 14482, 14510, 14711–14713, and 16356.

15153 (ANL–7313) THE DEVELOPMENT OF A DESIGN AND FABRICATION METHOD FOR PLUTONIUM-BEARING ZERO-POWER REACTOR FUEL ELEMENTS. Shuck, A. B.; Jelinek, H. F.; Hins, A. G.; Carson, N. J. Jr.; Denst, A. A.; Steele, T. A. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 92p. Dep. CFSTI.

Approximately 20,000 Pu-containing fuel elements are required for physics experiments and mockup of large-scale fast reactors. These elements are in the form of stainless steel-jacketed, rectangular plates, ¼ in. thick by 2 in. wide, and of varying lengths from 1 to 9 in. The gross weight of the cores will be approximately 14,000 kg, and the plutonium content will be approximately 4000 kg. Of this, 2900 kg of plutonium will be produced as U-28.3 wt % Pu-2.5 wt % Mo alloy core plates. The plutonium in these core plates will be approximately 87% fissile plutonium and 13% nonfissile Pu. The fissile-Pu content will be adjusted to 25 wt % of the core-plate weight. Other Pu isotopic compositions, alloys, and oxides will make up the core plates of the remaining fuel elements. The choice of the U–Pu–Mo alloy was made to avoid the rapid oxidation and pyrophoric properties of the binary U–Pu alloys in air. At temperatures below 600°C, the alloy cannot be deformed without rupture, and extremely good protective atmospheres are required if it is to be worked in the plastic range above 600°C. The method selected for development was casting the alloy into refractory-coated carbon molds to form semiprecision bars from which the core plates were machined. Although hard and brittle, the alloy is machinable at room temperature with WC-tipped tools. Jackets were fabricated from precisely formed, Type 304L stainless steel, rectangular sleeves and end plugs that were welded into the sleeves. Techniques that do not radioactively contaminate the outer surfaces were developed to load the core plates into the jackets. The final weld was made with the end plugs placed against the ends of the cores. This provided a finished element that expands immediately when heated by a reactor power excursion. The closing weld was also made in a reduced pressure (approximately ⅓ atm) of Ar–He gas mixture. The proposed method of fuel-element manufacture was tested by the pilot fabrication of fuel elements and the investigation was extended to a study of fabrication costs for manufacture of a production lot of fuel elements. The work culminated in a specification to be used for the commercial and AEC plant fabrication of U–Pu–Mo alloy fuel elements for the Zero Power Plutonium Reactor and for ZPR-6 and -9 experiments. (auth)

15154 (NLCO–1010) SUMMARY TECHNICAL REPORT FOR THE PERIOD OCTOBER 1–DECEMBER 31, 1967. Burgett, R. (ed.) (National Lead Co. of Ohio, Cincinnati). Feb. 1968. Contract AT(30-1)-1156. 22p. Dep. CFSTI.

Sixty-pound ingots were cast under controlled conditions to study the effect on uranium carbide segregation of carbon in the charge, temperature of the melt at the time of pouring, and mold temperature. The total carbon content of the ingot depended on the temperature of the melt at pouring and the carbides segregated more at higher pouring temperatures, at higher mold temperatures, and at higher ingot carbon levels. The resistance to deformation and hardness of cast uranium containing as much as 1000 ppM of each of two of the following elements: carbon, iron, silicon, and aluminum, was measured at temperatures ranging from 885 to 1200°F. Silicon and aluminum additions caused greater resistance to deformation and greater hardness than did carbon and iron. Cathodoluminescence may provide a useful analytical technique and extend the range of the electron microprobe. Quantitative analysis using cathodoluminescence is shown to be mathematically possible. Qualitative analysis is considered possible in special cases. A number of anticipated problems are discussed. (auth)

15155 (ORNL-TM–2074) PRELIMINARY STUDY OF PYROLYTIC TUNGSTEN DEPOSITION. Hobson, D. O. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 37p. Dep. CFSTI.

For a better understanding of the process of pyrolytic tungsten deposition pressures, flow rates, and H_2/WF_6 ratios for specific mandrel sizes and a specific mandrel temperature were optimized. Deposition efficiency varied with both pressure and gas ratio. Data on total flow rates, WF_6 flow rates, amount deposited, and efficiency are presented graphically. X-ray diffraction showed the deposits to be preferentially oriented in the growth direction. Analysis of the data indicated that the tendency for nodular growth was a direct function of gas composition. The experimental results were extrapolated to produce working hypotheses for predicting the behavior of tungsten deposition under a variety of conditions. (auth)

15156 APPLICATION OF THERMAL PLASMA IN NUCLEAR ENGINEERING. Riedel, Josef Tadensz. Przegl. Elektron., No. 1, 19-25; 28-9(1967). (In Polish).

The author discusses a number of applications of thermoelectric plasma in nuclear engineering, with particular attention to the possibilities of employing high temperatures for the purpose of obtaining coatings and films of refractory materials in the form of intermetallic compounds as well as cerium-metal alloys. Other important physicochemical properties considered, in addition to heat-resistance and melting points above 3,000°K, are radiation absorption and dilatability. The factors influencing plasma heating and the reaction processes involved in this process are discussed in some detail. The roles of ionization potential, ionization energy, and electron affinity, as they relate to thermal plasma work, are briefly explained. Analyzing the possible employment of thermal plasma techniques in the development of new and improved radiological shielding materials, the author lists boron, cadmium, indium, and europium as among the most important compounds from the point of view of neutron absorption potential. The problem of plasma temperature measurement is also discussed, with special reference to the use of the optical-monochromatic pyrometer. An accuracy of 1% with respect to absolute temperature in a range from 3,000 to 9,000°K is within reasonable expectation. Inadequacy of the chemical and physical properties of the materials employed in temperature measurement instrumentation represent one of the principal problems to be overcome in this area. (ATD)

15157 ELECTRON-BEAM MELTING OF NIOBIUM- AND TANTALUM-BASE ALLOYS. Belyaev, V. A. Tsvetn. Metal., No. 4, 75-7(1967). (In Russian).

High-vacuum electron-beam furnaces cannot be used to melt alloys containing volatile metals. In this connection, the possibility of melting niobium- and titanium-base alloys, such as Nb–Ta, Nb–Ti and Mo–Ti alloys was studied. Ingots (150 to 200 g) were electron-beam remelted 2 or 3 times in a vacuum of 133.3×10^{-4} to 666×10^{-4} neutrons/m^2 (n/m^2). The Nb–Ta ingots were directly cold rolled at 98 to 90% total reduction to 0.1 to 0.12 mm strip. Ti–Nb and Ti–Mo ingots, rolled under the same conditions, developed cracks along the grain boundaries; they were rolled in a vacuum of 133.3×10^{-4} to 666.5×10^{-4} n/m^2 at 900°C to strip 0.5 to 0.7 mm thick and then cold rolled to 0.2 mm with three process annealings. The hardness increased by 25 to 40%. The oxidation rate of Nb–Ta alloys in air was relatively high and increased with increasing Ta content. In Ti–Mo alloys, the oxidation increased with Mo content. A sharp increase of oxidation rate of alloy with 15% Mo at 1000 to 1100°C may be explained by α-phase decomposition. The oxidation rate in air of Ti–Nb alloys at first decreases with increasing Nb content (up to 15%) and then increases. The relatively low oxidation rate of Ti–Nb and Ti–Mo at 800 to 900°C is attributed to a dense oxide film which prevents further oxidation and makes it possible to hot work the alloys in air. (JPRS)

15158 ELECTROLYTIC DEPOSITION OF MANGANESE–MOLYBDENUM ALLOYS. Byarnotas, A. K.; Bubyalis, Yu. S.; Matulis, Yu. Yu. (Inst. of Chemistry and Chemical Tech., Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, No. 4, 55-63(1966). (In Russian).

An investigation was made of a method for the electrolytic deposition of manganese-molybdenum alloys from manganese sulfate solutions. The experiments were carried out at 20°C on an iron cathode and an electrolyte containing manganese sulfate, ammonium sulfate, thioglycolid acid, and ammonium molybdate. Thioglycolid acid promoted the deposition of manganese-molybdenum compounds. An alloy containing up to 5% molybdenum was

obtained from an electrolyte containing 105 g/l manganese sulfate, 60 g/l ammonium sulfate, 21.2 g/l thioglycolid acid, and up to 7 g/l ammonium molybdate at pH = 4.1 and a current density of 4–10 amp/dm^2. (ATD)

15159 STRUCTURAL STABILITY OF A WELDED JOINT OF 12 PERCENT CHROMIUM STEELS AND OF Cr–Mo–W–V-TYPE STEELS. Pilous, Vaclav; Jandos, Frantisek. Kovove Mater., 4: 478-504(1966). (In Russian).

An examination was conducted of the structural stability of welded joints between modified 12% chromium steel and medium-alloyed steel CrMoWV used in the construction of power plants. It is stressed that the structural stability of the transition zone between the weld and the parent material is of primary importance during service at high temperatures. It is demonstrated that the structural stability is disturbed chiefly in the transition zone between the medium-alloyed base metal containing higher carbon content and the modified 12% Cr weld-metal with lower carbon content. The structural instability is caused by diffusion due to the equalization of the thermochemical differences between the carbon in the two solid solutions. The structural stability is shown to be higher in joints welded by means of medium-alloyed electrodes of the CrMoV type. (IAA)

15160 PREPARATION OF VAPOR-DEPOSITED TUNGSTEN AT ATMOSPHERIC PRESSURE. Mehalchick, Emil J.; MacInnis, Martin B. (Sylvania Electric Products Inc., Towanda, Pa.). Electrochem. Technol., 6: 66-9(Jan.-Feb. 1968).

Coherent deposits of tungsten were obtained at atmospheric pressure by the hydrogen reduction of tungsten hexachloride. The process is very temperature dependent. Optimum deposition rates were obtained at 600°C. The morphology of the tungsten deposits was found to be directly related to the oxygen content of the tungsten hexachloride and the reaction temperature. (auth)

15161 LOW-TEMPERATURE EXTRUSION OF REFRACTORY METALS. Moguchy, L. N. Kuznecho-Shtampovochyne Proizvod., No. 1, 11-13(Jan. 1967).

Hydraulic press extrusion of W and Mo rods, 25 mm in diameter, into rods of smaller diameter at 20 to 600°C uses oil and graphite as lubricants. To decrease the extrusion stresses and to increase the life of die orifice, the rods (W or Mo) are sheathed into tubes of Al, Cu, Armco iron, or a combination of these. It has been determined that Al sheaths are not applicable since their use results in necking of the rods. The sheaths of Fe or Cu, or a combination of Cu and Fe, result in uniform plastic flow of metal. After extrusion the rods are annealed at 600°C to reduce the possibility of microcracks. Optimum extrusion temperatures are recommended for the tested sheaths. Comparison is made of the microstructure of Mo extruded at 400°C and at 200°C. (Rev. Metal Lit.)

15162 AN EVALUATION OF THE ELECTROLYTIC GRINDING OF TUNGSTEN CARBIDE. PART II. Hughes, F.; Notter, A. Mach. Shop Eng. Mfg., 28: 262-6(July 1967).

Effects of the size of the carbide tip and shank steel on the cost of grinding and of the area of the shank material on grinding time were determined on WC/steel grinding combinations. Results show that, in the electrolytic grinding process, the maximum area of combined carbide and shank steel that can be ground economically is 25 × 25 mm. Electrolytic diamond grinding and conventional abrasive grinding using SiC wheels were evaluated for regrinding broken tools used for machining steel castings and having tips of WC. The electrolytic process is shown to eliminate the thermal cracking which sometimes occurs in conventional grinding. Tests with electrolytic diamond wheels of 200 and 300 mm dia show that the smaller wheel is more expensive to operate over the entire range of work/wheel interface pressures. Other tests show that, in the electrolytic diamond grinding process, 75% of the work is done by electrochemical processes and 25% by mechanical abrasion. (Rev. Metal Lit.)

15163 EVALUATION OF THE ELECTROLYTIC GRINDING OF TUNGSTEN CARBIDE. Hughes, F.; Notter, A. Mach. Shop Eng. Mfg., 28: 218-23(June 1967).

Electrolytic grinding with a metal-bonded diamond wheel has been evaluated for grinding WC tips, combinations or WC tip and shank steel and for regrinding used WC tipped tools. Grinding with silicon carbide, aluminum oxide and electrolytic boron carbide wheels has also been studied to determine whether these wheels can effectively replace diamond. Recommended oscillation rates and work/wheel interface pressures are given. With the diamond grinding method, roughing and finishing are completed in one operation. Boron carbide is completely unsuitable because of high electrical conductivity, and silicon carbide and aluminum oxide require the use of a final diamond grinding for the required surface finish. (Rev. Metal Lit.)

15164 STRIP CLADDING OF STEEL WITH STAINLESS AND NICKEL-BASED ALLOYS. PART I. INTRODUCTION AND WELDING RESULTS. Horsfield, A. M.; Almqvist, G.; Rosendahl, C. H. Svetsaren (English), No. 2, 12-16(1967).

The submerged arc strip cladding process was used for cladding reactor vessels and heat exchangers for nuclear applications, pressure vessels and tanks for the chemical industry, parts for water turbines, and rolls for paper mills. Since users of the process showed the greatest interest in cladding with stainless steels, most of the development work was done with stainless strips. The following different parent metal/clad layer combinations were investigated: mild steel, 0.30% C-Mn plate, and low alloy (Ducol W 30) parent metals clad with 18/8 stainless steel; low alloy (Ducol W 30) clad with 18/22/2.5% Mo stainless steel; low alloy (Ni-Mo-V) anti mild steel clad with 18/8 Nb stabilized stainless steel; mild steel clad with 13% Cr and 17% Cr steel; 0.25% C-Mn rolls clad with Ni; mild steel clad with Inconel; and mild steel clad with Monel. The following tests were performed; chemical analysis of the clad layer, side bend tests, visual inspection, determination of ferrite content in the clad layer (for stainless steels), metallurgical examination, and crack detection by ultrasonic and dye-penetrant methods. Electron probe microanalysis was used to investigate the constitution of the fusion boundary between the plate and the first layer of cladding. Welding techniques for the different material combinations are described. (Rev. Metal Lit.)

15165 PRODUCTION AND TESTING OF PLASMA SPRAY COATINGS. Matting, A.; Delventhal, B. Blech., 13: 551-5 (Nov. 1966). (In German).

Tests with the spraying of ceramic and high-melting metal layers on structural steel plate specimens, using a laboratory and a commercial plasma spraying device, were performed using Mo and NiCr 80-20. A Ni-Al powder mixture and Al were used as the intermediate layer for ceramic coatings. Test methods for adhesion, thermal fatigue resistance, and insulating characteristics of plasma-sprayed layers are described. Best adhesion was obtained with plasma-sprayed Fe coatings, followed by Mo, Al and W. Among the ceramics, the adhesion behavior of ZrO_2, and among metal-ceramics, that of mixtures of Ni and Al (Metco 404), NiCr and ZrO_2, NiCr and Al_2O_3 + TiO_2, was most favorable. The adhesion of plasma-sprayed coatings is a function of the nature of the gas, the amount of the gas, and the current. The structure of such layers is similar to that of flame- or arc-sprayed coatings, but with somewhat reduced porosity. Thermal fatigue tests revealed that oxidation effects appear after exposures at rising temperatures, indicating that the layers are completely gastight. (Rev. Metal Lit.)

15166 NEW PLATE TECHNOLOGY EQUALS NEW MARKETS. Kobrin, C. L. Iron Age, 200: No. 4, 71-4(July 27, 1967).

A new plate steel was developed, LT-75HS, with a yield strength of 75,000 psi and notch toughness of 15 ft-lb at –75°F for earth-moving equipment, mobile cranes, power shovels and offshore drilling rigs. LT-75HS contains 0.22% C and 1.10 to 1.6% Mn. A significant increase in heavy-gage steel plate shipments has been generated largely by the petroleum and nuclear industries. The use of chrome-moly steel for hydrocrackers has increased twelvefold. For this critical service, Lukens produces plates of 2¼% Cr-1% Mo steel up to 8-in. thick and weighing over 30 tons. A Mn-Mo steel, A 302B, now known as ASTM A 533, was produced in thicknesses up to 11¾ in. for five 1000-MW pressurized water reactor vessels. (Rev. Metal Lit.)

15167 ELECTROLYTIC TREATMENT OF PRISMATIC WORKPIECES. Chauvin, Guy; Facquet, Louis; de Fouchier, Alain; de Vaulchier Du Deschaux, Louis (to Commissariat a l'Energie Atomique). British Patent 1,097,358. Jan. 3, 1968. Priority date Aug. 25, 1965, France.

A process and a device for the electrolytic treatment of prismatic-shaped workpieces is described with particular application to U parts or parts formed of U-base alloys. The part to be treated is supported on the lower portion of a coiled spring having a horizontal axis. The coils of the spring are so shaped as to define a prismatic shape having a transverse cross section in the shape of a regular polygon with N sides, which are of slightly greater length than the long sides of each part. At least that portion of the spring that contains the part to be treated is immersed in an electrolytic bath. The spring is moved in such a manner as to include rotation about its axis so as to initiate the periodic reversal of the part and the modification of its zones of contact with the spring. An electric voltage difference is established between the bath and the part. (B.L.M.)

15168 METHOD FOR MAKING NIOBIUM–URANIUM ALLOY WITH PREDETERMINED TOTAL VOID VOLUME AND VOID SIZE. Wilhelm, Harley A.; McClusky, James K. (to United States Atomic Energy Commission). U. S. Patent 3,369,890. Feb. 20, 1968.

A method of making homogeneous niobium-uranium alloys with predetermined void sizes and total void volume is described. The carbon to oxygen ratio of a mixture of niobium oxide, uranium oxide and carbon is varied. The mixture is then sintered under vacuum to a temperature below the melting point of the resulting alloy. (AEC)

Properties Evaluations

Refer also to abstracts 14667, 15154, 15256, and 15631.

15169 (ANL-7272) ELASTIC MODULI AND ULTRASOUND VELOCITIES OF TUNGSTEN AS A FUNCTION OF TEMPERATURE. Peterson, Ronald G. (Argonne National Lab., Ill.). Dec. 1967. Contract W-31-109-eng-38. 10p. Dep. CFSTI.

The results of a preliminary study of the elastic moduli and the ultrasound velocities of tungsten are given. The data were obtained by an ultrasonic pulse-echo method. (auth)

15170 (BMwF-FBK-67-88) UNTERSUCHUNGEN AN ALUMINIUMREICHEN URANLEGIERUNGEN. (Studies on Aluminum-Rich Uranium Alloys). Petzow, G.; Exner, H. E. (Max-Planck-Institut fuer Metallforschung, Stuttgart (West Germany). Institut fuer Sondemetalle). Dec. 1967. 69p. (In German). Dep.

Investigations of Al–U alloys with ternary additions have shown that stabilization of the UAl_3-phase with respect to UAl_4 is not caused by retarded UAl_4 formation, but it can definitely be explained by the equilibrium structure of the corresponding ternary systems. The formation of a two phase relation between UAl_3 and Al is prerequisite for a stable UAl_3 phase in Al–U alloys with less than 10 at % U. The constitution of the systems Al–UAl_2–$ZrAl_2$, UAl_2–NiAl and Al–UAl_2–NiAl is presented. Furthermore, results of oxidation resistance studies of several intermetallic phases are reported. (auth)

15171 (BNWL-641) TRIP REPORT, DISCUSSIONS ON FTR SHIELD AND CONTROL-ROD MATERIALS. Helm, J. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

Discussions and information obtained on Fast Test Reactor (FTR) shield and control-rod materials are summarized. Materials data and samples of specific materials that companies propose for use as FTR shield or control-rod materials are discussed. Data on carbon, graphite, carbon–graphite, enriched boron carbide, and serpentine rock were obtained. Samples for test purposes were arranged for all materials except the enriched boron carbide. Samples of serpentine rock are being tested. (J.C.W.)

15172 (CEND-3742-325) VANADIUM PURIFICATION. Quarterly Progress Report No. 4, May 1–September 30, 1967, Shen, Y. S.; Worcester, S.; La Vake, J. C.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Nov. 1967. Contract AT(30-1)-3742. 32p. Dep. CFSTI.

A 27.1-pound high-purity vanadium ingot was produced using commercial melting equipment and techniques. However, this ingot does not meet the target requirements of the program in that the interstitial content is high, and the ingot too small. As specified for this program, the target impurity levels are $0 \leq 300$, $N \leq 100$ and $C \leq 100$ ppM with a final ingot weight of approximately 100 pounds. Chemical analysis on the 27-pound ingot showed generally a high nitrogen content (approximately 300 ppM) with the remaining impurity elements within the target values. Although this ingot did not meet the target requirements, much information was learned concerning control of chemistry as a result of processing this ingot. Fabrication of a third ingot has been started and information derived from processing the second ingot will be used to control the chemistry within the target requirements and produce a 100-pound ingot. (auth)

15173 (EURAEC-1963) QUARTERLY REPORT NO. 10 [ON REACTOR MATERIALS], JULY 1, 1967–SEPTEMBER 30, 1967. (Chantiers de l'Atlantique Saint-Nazaire (France)). Jan. 9, 1968. Contract 054-61-12-RDF. 5p. (EUR-3772). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Two new steels MANNESMANN WB 35 and vacuum degassed Mn Mo, were investigated. Impact strength decreases if tempering treatments are protracted, but impact strength is improved by brief tempering. Relaxation tests were terminated on steels in the normalized and normalized plus tempered states. The initial stress was equal to the elastic limit at ambient temperature increased by 2 hbar. Results are tabulated for 550 and 600°C. (J.C.W.)

15174 (GEAP-5554) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 10, July–September 1967. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1967. Contract AT(04-3)-189. 134p. Dep. CFSTI.

PIPES—fatigue testing of primary coolant, stress ratio analysis for
STRESS—analysis of primary coolant pipe reliability
CRACKS—analysis of primary coolant pipe, computer program for stress; analysis of primary coolant pipe joints; measurement in cylinders of low carbon steel, Type 304 stainless steel, and chromium–molybdenum steel, at room temperature
PIPE JOINTS—fatigue testing of primary coolant, stress analysis for crack
CARBON STEEL—pipe joints of low, limiting stress testing at 25 and 60°F of; fatigue testing at room temperature of cylinders of, analysis of
TENSILE PROPERTIES—measurement of low carbon steel pipe joints at 25 and 60°F
CHROMIUM STEEL—Cr–Mo, fatigue testing at room temperature of cylinders of, analysis of
MOLYBDENUM STEEL—Cr–Mo, fatigue testing at room temperature of cylinders of, analysis of
STRAIN—measurement in cylinders of low carbon steel, Type 304 stainless steel, and chromium–molybdenum steel, at room temperature
STRESS—measurement in cylinders of low carbon steel, Type 304 stainless steel, and chromium–molybdenum steel, at room temperature
MATERIALS TESTING, DESTRUCTIVE—fracture stress in cylinders of low carbon steel, Type 304 stainless steel, and chromium–molybdenum steel at room temperature
STAINLESS STEEL—fatigue testing at 550°F of Type 304, effects of boiling water on low-cycle; pipes of Type 304, crack growth at room temperature in; crack growth in Type 304, measurement at 550 and 650°F of; fatigue testing at room temperature of cylinder of Type 304, analysis of
REACTOR COOLANTS—effects of boiling water on Type 304 stainless steel at 550°F, fatigue testing (D.L.C.)

15175 (GEMP-1002) AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM PROGRESS REPORT NO. 71. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Dec. 29, 1967. Contract AT(40-1)-2847. 144p. Dep. CFSTI.

Nine sections on reactor materials development are presented. A separate abstract was prepared for each section. (J.C.W.)

For abstracts of individual sections see: 15143, 15144, 15176–15181, and 15225.

15176 (GEMP-1002, pp 11-37) PHYSICAL AND MECHANICAL PROPERTIES OF REACTOR MATERIALS. Conway, J. B.; Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The creep-rupture characteristics for wrought arc-cast Mo–30W (wt %) at 1600 and 2200°C are compared with data for unalloyed molybdenum and tungsten, which on a homologous temperature basis exhibited the same behavior. The Mo–30W data show a 17 percent increase in the 100-hour rupture stress at both 1600 and 2200°C. No detectable primary creep (first stage) was observed at any of the test conditions evaluated. Creep-rupture data for wrought arc-cast unalloyed tungsten and W–25Re (wt %) for the temperature range of 1600 to 3000°C show the superiority of unalloyed tungsten. Creep-rupture data at 1600 and 2200°C for Mo–5Re and Mo–5W (at. %) sheet, fabricated by the powder-metallurgy process, show a greater rupture life than that for wrought arc-cast molybdenum at both temperatures. No significant difference in the rupture life or linear creep rate is observed for the two alloys. Optical, electron microscopy, and x-ray diffraction techniques were used to evaluate the subgrain size as well as dislocation density and distribution for wrought arc-cast tungsten, creep tested at 1600 to 3000°C and stresses from 0.18 to 5.62 kg/mm^2. Comparisons show that the replica electron microscopy technique produced truly representative images of the surface features of specimens at considerably higher magnification and resolution than was possible by optical methods. Using this technique, counting of free etch pits, as well as those in the subgrain boundaries, was possible for highly stressed samples. Good agreement was obtained between x-ray diffraction and optical measurements of subgrain diameters although diameters using the x-ray technique were generally higher. The spacing of dislocations in the subgrain boundaries was calculated to range from approximately 300 to 1300 Å with the tilt angles between subgrains averaging 0.16 degree. Thermal conductivity and electrical resistivity studies of W–26Re at 300 to 2300°C resulted in an expression for thermal conductivity in terms of resistivity and temperature.

Thermal diffusivity data for W–25Re from 300 to 1000°C were obtained using a laser technique. Good correlation is shown with calculated values from thermal conductivity (W–26Re), heat capacity, and density. Enthalpy and heat capacity equations for unalloyed tungsten are presented for the range 1200 to 3250°K. (auth)

15177 (GEMP–1002, pp 65–76) REFRACTORY-METAL ALLOY RESEARCH AND DEVELOPMENT. Funston, E. S.; Tarr, C. O. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Work is continuing on research for the development of ductile Mo. Recently 24 specimens were processed into sheet to verify workability and weldability. Bends of 45 to 90 degrees were completed at room temperature on welded sheet. Ductile Mo has also been cold-drawn into seamless tubing. A large specially designed tube draw bench was installed which can handle tubing up to 5 cm in diameter to finished lengths of 366 cm. It is instrumented to determine processing parameters required in tube forming. Six hydraulically operated and controlled tube draw benches have also been installed to permit repetitious tube drawing. (auth)

15178 (GEMP–1002, pp 77–82) PHYSICAL METALLURGY OF REFRACTORY METAL ALLOYS. Collins, C. G.; Bohlander, K. M. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Two methods of achieving good room-temperature bend ductility were found for W–25Re–30Mo and W–30Re–30Mo alloys extensively cold reduced without intermediate anneals. These included multiple rolling passes of sheet with essentially no reduction, and annealing treatments at 1800°C. Aging of specially purified powder-metallurgy W–25Re–30Mo and W–30Re–30Mo alloys indicated very stable microstructures for periods of 1000 hours at temperatures below 1600°C. At higher temperatures, secondary recrystallization occurred in five of 10 sheets of the W–25Re–30 Mo alloy examined. Efforts to identify sheets susceptible to secondary recrystallization by x-ray fluorescence and x-ray diffraction techniques were not successful. (auth)

15179 (GEMP–1002, pp 83–93) ADVANCED LONG-LIFE REACTOR FUEL CLADDING AND STRUCTURAL MATERIALS DEVELOPMENT. Robertshaw, F. C.; Bartos, J. L. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Exploratory Na environment tests on Cr–20V and three primary Cr-base alloys confirmed that these alloys possess excellent stability in low-oxygen Na at 650°C. Modifications in creep-rupture testing procedures have been adopted for Cr-base alloys in an effort to reduce interstitial element contamination during testing. High-purity Cr-V alloys are being prepared for ductility studies. Charpy V-notch versus subsize impact specimen data obtained for an Fe–Cr–Al–Y alloy reveal that the Charpy V data indicate a higher DBTT. No major effects on structure or tensile strength resulted from processing variations of Fe–Cr-base alloys. (auth)

15180 (GEMP–1002, pp 94–107) EVALUATIONS OF THE PLASTIC FATIGUE PROPERTIES OF HEAT-RESISTANT ALLOYS. Conway, J. B. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

The strain-cycling fatigue characteristics of Type 316 stainless steel tested in air are presented for temperatures of 430°, 650°, and 816°C and an approximate strain rate of 4×10^{-3} sec^{-1}. The 316 data at 650°C exhibited less fatigue resistance than either the 304 or 348 stainless steels. The fatigue resistance of 316 stainless steel at 430°C is comparable with that of 348 stainless steel. Strain hardening followed by strain softening was observed for 316 stainless steel at 430°C over the entire strain range evaluated. The fatigue data generated for 304 and 348 stainless steel at 650°C and an approximate strain rate of 4×10^{-5} sec^{-1} seem to coincide with the data obtained at 816°C and an approximate strain rate of 4×10^{-3} sec^{-1}. A Manson–Halford analysis was made of the fatigue data generated to date for Types 304, 348, and 316 stainless steel at 650°C and 816°C at a strain rate of approximately 4×10^{-3} sec^{-1}. In general, the data lie near the predicted upper bound except for the 348 stainless steel data. Also, all the exponential data generated at strain ranges less than approximately 0.5 percent are more conservative than the upper bound predictions. Metallographic and fractographic techniques have been established to permit a more detailed evaluation of fatigue samples. Preliminary fractographic studies of Types 304 and 348 stainless steel fatigue samples tested in air at an approximate strain rate of 4×10^{-5} sec^{-1} revealed striation-free fracture surfaces in the vicinity of the crack initiation point. (auth)

15181 (GEMP–1002, pp 108–22) ADVANCED PRESSURE VESSEL MATERIALS. Robertshaw, F. C.; Stephan, H. R. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Base-metal property data have been determined for 12Ni–5Cr–3Mo steel, PH13–8Mo steel, and Inconel alloy 718. Variation in tensile properties with orientation was very low (~3%) for Inconel alloy 718, low (~6%) for 12Ni–5Cr–3Mo maraging steel, and relatively high (~14%) for PH13–8Mo precipitation-hardening stainless steel. Strength levels obtained on PH13–8Mo were in accord with preliminary vendor data, but lower than expected for the 12-5-3 alloy and Inconel alloy 718. The impact strength of all alloys also showed a sensitivity to orientation. Room-temperature Charpy V-notch data for the three alloys under the particular conditions of heat treatment employed are given. Weldment strength data were generally lower than comparable base metal data. Radiation studies of all alloys are continuing. (J.C.W.)

15182 (IS–1757) TECHNOLOGY AND USES OF BERYLLIUM, CESIUM, GERMANIUM, HAFNIUM, NIOBIUM (COLUMBIUM), RARE EARTHS (INCLUDING YTTRIUM AND SCANDIUM), TANTALUM, TITANIUM, AND ZIRCONIUM. Gschneidner, Karl A. Jr. (Ames Lab., Iowa). Jan. 1968. Contract W-7405-eng-82. 158p. Dep. CFSTI.

The chemical, metallurgical, and physical properties of beryllium, cesium, germanium, hafnium, niobium, rare earth, tantalum, titanium, and zirconium metals and their principal compounds are reviewed, especially in light of their importance in present day technology and applications. The use of these metals and their compounds in industry, and in basic and applied research, such as space, nuclear energy, and electronics, is discussed. Special problems associated with these materials are noted and commented upon. (253 references) (auth)

15183 (IS-T–212) THERMAL EXPANSION OF THE SESQUIOXIDES OF YTTRIUM, SCANDIUM, AND GADOLINIUM. Stacy, Denzil Wayne (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 45p. Dep. CFSTI.

Thesis.

Linear thermal expansion measurements of the sesquioxides of yttrium, scandium, and gadolinium were made from room temperature to 1100°C with a sapphire-rod dilatometer. Dilatometer design and calibration were described. Expansion measurements were made on both the monoclinic and cubic forms of gadolinia. Purity, firing conditions, and apparent density of the specimens were reported. The over-all coefficients of linear thermal expansion from 25 to 1100°C were found to be 7.93×10^{-6} in./in. °C for yttria, 8.54×10^{-6} in./in. °C for scandia, 9.49×10^{-6} in./in. °C for monoclinic gadolinia, and 7.61×10^{-6} in./in. °C for cubic gadolinia. Results were compared with those obtained previously. (auth)

15184 (KAPL–3360) INFLUENCE OF IRON SEGREGATION ON THE MECHANICAL PROPERTIES OF REACTOR-GRADE HAFNIUM. Calhoun, C. D.; Fascia, J. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 15, 1967. Contract W-31-109-eng-52. 10p. Dep. CFSTI.

A brief study of the effects of various heat treatments on the mechanical properties of reactor-grade hafnium has been accomplished. Three tensile specimens of reactor-grade hafnium were tested: one in the as-received condition and two in heat-treated conditions. The mechanical properties (yield strength, ultimate tensile strength, elongation, and reduction in area) were reduced significantly by the more severe of the two heat treatments investigated. The fracture surfaces of the three tensile specimens were studied by both light and electron microscopy. The results of these studies revealed that segregation of a solute had occurred at the grain boundaries. Electron microprobe analysis established the solute as iron. (auth)

15185 (ORNL–4210) FLOATING-MANDREL EXTRUSION OF TUNGSTEN AND TUNGSTEN-ALLOY TUBING. McDonald, R. E.; Reimann, G. A. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Tungsten and tungsten-alloy tubing were extruded successfully from arc-cast and powder-metallurgy billets by use of the floating-mandrel technique with naturally forming tungsten oxide as a lubricant. Extrusion temperatures ranged from 1650 to 2250°C, and extrusion ratios were in the range of 4 to 9. Satisfactory service was obtained from zirconia-protected dies and mandrels, but surface melting of the container sleeve began when billet temperatures exceeded 1850°C. Rapid extrusion speeds were necessary to minimize heat loss and reduce contact time with the tooling. Thin-walled tungsten tubing was produced with the floating-mandrel technique by reextruding a section of tube shell in a duplex billet. (auth)

15186 (SC–RR–67–2975) ROLE OF SUBGRAINS DURING THE CREEP OF PURE ALUMINUM. Stein, Charles (Sandia

Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 37p. Dep. CFSTI.

An electron microscopy study was made of the behavior of the substructure developed in pure aluminum during creep at 260°C and a constant stress of 1000 psi. During primary and secondary creep, the tests were interrupted, the specimens air cooled and changes in subgrain size and of misorientation across sub-boundaries, from those of a light dislocation tangle appearing during primary creep to those which display Moiré fringes in secondary creep. While the subgrain size continuously decreases during the second stage from the annealed value of 60μ to 2μ, the misorientation, as measured by splitting in the Kikuchi line patterns, increases from 0.04 to 0.14 degrees. A comparison of the dislocation interactions during primary creep with the tangling theory of sub-boundary formation of Wilsdorf is presented. (auth)

15187 (UCRL-50315) THE SOLUBILITIES OF TRANSITION METALS IN LIQUID ALKALI AND ALKALINE EARTH METALS, LANTHANUM AND CERIUM: A CRITICAL REVIEW OF THE LITERATURE. Anthrop, Donald F. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 20, 1967. Contract W-7405-eng-48. 92p. Dep. CFSTI.

A critical review of the literature on solubilities of transition metals in liquid alkali and alkaline earth metals, cerium, and lanthanum is presented. The work of each investigator is described and his results are given. Solubility data are presented in graphical form as plots of log X vs 1/T, where X is the mol fraction of solute metal in the liquid metal solution, and partial molal heats of solution for the solute metals are calculated. Conclusions are presented where warranted by the existing data. Effects of impurities on solubilities of solute metals in liquid metals are discussed and some conclusions are reached from the available data. Those areas in which further research is most urgently needed are outlined. (auth)

15188 (Y-1593) DETERMINATION OF SELECTED MECHANICAL AND PHYSICAL PROPERTIES OF CAST VERY-HIGH-ASSAY URANIUM. Legacy, D. J.; Yaggi, W. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 29, 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Mechanical and physical tests were performed on very-high-assay (97.5% ^{235}U) uranium castings. The castings were sampled at locations selected to determine any edge-to-center or top-to-bottom variation in properties. The test results, subjected to statistical analysis, indicated that the properties were uniform within each casting and among castings. (auth)

15189 (EURFNR-348) INVESTIGATION INTO HIGH-TEMPERATURE EMBRITTLEMENT AFTER NEUTRON IRRADIATION OF 16/13 CrNi STEELS. Boehm, H.; Hauck, H.; Hess, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report PSB-266/67. 24p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

On austenitic steels of the 16/13 CrNi type, the influence of the boron content and of the carbon content, as well as the influence of a combined deformation and heat treatment on the high-temperature embrittlement following a neutron irradiation, was investigated in the hot tensile test at 750°. The results of investigations on nonstabilized steels prove that, with C concentrations between 15 and 50 ppM, there is no dependence of the embrittlement (characterized by the breaking elongation) on the B content. With respect to the C content, the experiments point to the fact that the dissolved carbon does not have any effect on the extent of the embrittlement, in the presence of C contents which lead to carbide separation, but that a reduction of the embrittlement takes place. The investigation made on Nb-stabilized steel concerning the influence of a combined deformation and heat treatment on the irradiation behavior has shown that in those cases in which the heat treatment has led to recrystallization, a decrease of embrittlement by irradiation goes parallel with the degree of dispersion of the carbide particles which increases with increasing degree of deformation. With degrees of deformation by irradiation up to 30% on account of which the subsequent heat treatment does not cause any recrystallization, the total embrittlement increases with the degree of deformation, whereby, however, only the embrittlement caused by irradiation diminishes, even down to zero. (auth)

15190 (EURFNR-382) URANIUM DIOXIDE THERMAL CONDUCTIVITY AT VERY HIGH TEMPERATURE GRADIENTS. Patrassi, E. (Kernforschungszentrum, Karlsruhe (W Germany). Institut fuer Material und Festkoerperforschung). Translation of report KFK-561. 15p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A method was developed that permitted the measurement of the thermal conductivity of UO_2 over a large temperature range (300°C < T < 2000°C) with variable, controlled temperature gradients (30°C/cm < dT/dx < 5000°C/cm). The accuracy was a function of the temperature and temperature gradient varying between ±3 to ±8%. The measurements show that the thermal conductivity of UO_2 is a function of the temperature and the temperature gradient. The dependence is reversible as long as a specimen develops no cracks. The change in elastic properties which result from the thermal stresses produced in a thermal gradient may be responsible for this behavior. Large thermal gradients can also be expected to disturb the uniformity of lattice vibrations. The thermal conductivity exhibits a maximum at 1050°C. Large temperature gradients can also be responsible for this phenomenon. It is possible to correlate this result with the zero point of the Seebeck coefficient, as measured by other experimenters, since the electronic contribution to the thermal conductivity can exhibit a maximum in this temperature range. Measurements made in the high temperature region (1200°C < T < 2000°C) with large temperature gradients (5000°C/cm) show agreement with conductivity values measured in-pile. In this connection, the specimens employed exhibit columnar grains similar to those which appear in irradiated samples. This indicates that it is possible to simulate certain in-pile thermal conditions by this technique. (auth)

15191 USE OF A NEW METHOD INVOLVING LABELING WITH NONRADIOACTIVE ELEMENTS AND ACTIVATION ANALYSIS TO INVESTIGATE WEAR. Radwan, M.; Reven'ska-Koc'-tsyuk, B.; Vez'ranovski, E. (Inst. of Nuclear Research, Warsaw). pp 71-9 of Radioisotope Tracers in Industry and Geophysics. Vienna, International Atomic Energy Agency, 1967. (In Russian).

From IAEA Symposium on Radioisotope Tracers in Industry and Geophysics, Prague. See STI/PUB-142; CONF-661121.

In view of the considerable difficulties in using the labelled-atom method to investigate the wear of bearings in agricultural machines under operating conditions, and also to investigate the wear of fire-proof materials in steel production (owing to the occurrence of exogenous nonmetallic inclusions), attention was given to labelling these parts with nonradioactive elements, which were then determined by activation analysis. In the work carried out by this method either mixtures of rare-earth oxides or lanthanum oxide alone were used as tracers, because of their useful nuclear properties. The use of rare-earth elements is also justified by the fact that their chemical properties differ from those of the remaining elements in the material investigated, which means that they can be separated from the respective carriers. In investigations of the wear of agricultural machine bearings made from cast-iron modified with rare-earth elements in an amount too low to cause structural changes, the modifier was used as a tracer. The wear of polyamide bearings was also investigated. The use of activation analysis is particularly interesting in this case, since certain properties of the polyamide make standard methods of investigation completely impossible. The products of wear were separated from the oil or grease by extraction or combustion. In determinations of nonmetallic exogenous inclusions in ball-bearing steel, caused by certain fireproof materials, the wear of these materials was investigated using modern steel production technology. The aim of these investigations was to determine the effect of vacuum extraction and the use of induction mixers on the passage of fire-resistant particles into the steel. A method of determination was developed based on chemical separation of the tracer after activation with an appropriate surplus of nonradioactive carrier, and also a method of separating it before activation with a calcium carrier. The method based on chemical separation of the indicator before activation is regarded as the correct one, principally because it can be used in production laboratories not equipped for work with open radiation sources. In all experiments of this type the rare-earth elements must be separated from systems containing a considerable quantity of iron, which complicates direct deposition of the calcium oxalate together with oxalates of the rare-earth elements. A method was developed whereby the iron was bound to the oxalate anion by a complex bond and the rare-earth elements were separated with a calcium carrier in a weak acid medium. The results obtained from the investigations conducted have made it possible to draw a number of useful conclusions that are relevant to production technology. The method can be used to determine a mass of labelled material of the order of 10^{-6} g. (auth)

15192 CHARACTERIZATION OF CHEMISORPTION BY LEED. Estrup, P. J.; Anderson, J. (Franklin Inst., Swarthmore, Pa.). Surface Sci., 8: 101-14(1967).

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

Low energy electron diffraction (LEED) observations have been made on the interaction of a tungsten (100) surface with a number of adsorbates, including H_2, N_2, CO, Th and O_2. Based on these results, a discussion is given of the interpretation of LEED data for chemisorption systems. It is suggested that simple adatom addition, rather than surface reconstruction, may account for most of the diffraction data but an exact analysis of structure is in general prevented by the occurrence of multiple scattering. The information available from LEED patterns of incomplete structures is examined by means of some simple models and, finally, the interactions leading to superstructure formation are considered. (auth)

15193 QUANTITATIVE REFLECTION ELECTRON DIFFRACTION IN AN ULTRA HIGH VACUUM CAMERA. Siegel, Benjamin M.; Menadue, James F. (Cornell Univ., Ithaca, N. Y.). Surface Sci., 8: 206-16(1967).

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

An ultra high vacuum electron diffraction camera for intermediate energies (10 to 50 kV) is described. A Faraday cup scans the diffraction pattern while another monitors the incident beam, reading out the intensities with high accuracy. The performance of the instrument is illustrated with typical diffraction patterns and scans. Reasons are discussed for expecting that the intensity data from high-energy electron diffraction is more satisfactory than from low-energy electron diffraction for the determination of surface structure, since dynamical theory must be used. (auth)

15194 BERYLLIUM AND ITS ALLOYS. Electron. Packag. Prod., 7: No. 5, 59-62; 64; 66-8; 73-5; 78-9(May 1967).

Beryllium compares favorably with other metals in applications requiring light weight, stiffness, a coefficient of expansion matching ferrous and Ni-base alloys and low-thermal conductivity. Data are given for density, modulus of elasticity, strength-to-density ratio, notch sensitivity and thermal properties of Be as compared to Al alloys, Mg alloys and other materials. The most common alloys are composed of Be and Cu and can be alloyed for high strength, high electrical conductivity or a compromise choice of each. Conductivity, strength, corrosion resistance, fatigue and wear resistance, hardness, magnetic properties, and heat resistance data are given for typical compositions. A new free-machining Be–Cu alloy has been developed. A Be–Ni alloy has been designed for use in fabricated parts requiring high elevated-temperature tensile and yield strength, good formability, corrosion resistance in reducing media, and fatigue resistance. A Be–Al alloy (38% Al) combines high modulus, low density, and attractive shipping characteristics. (Rev. Met. Lit.)

15195 EFFECT OF AMBIENT MEDIA ON PROPERTIES OF PRESSURE-WORKED NIOBIUM. Amonenko, V. M.; Rybal'chenko, N. D.; Smirnov, Yu. N.; Tron', A. S.; Azhazha, V. M.; Mukhin, V. V.; Finkel', V. A. Tsvet. Metal., No. 4, 77-9(1967). (In Russian).

Niobium sheets heated and rolled in a vacuum of 133.3×10^{-5} newtons/m^2 (n/m^2) had an elongation of 31.0% and a reduction of area of 74.0%, compared with 15.0 and 36.0% for sheets heated and rolled in air, and 22.0 and 49.5% for sheets heated in vacuum and rolled in the air. Heating and rolling niobium in the air was accompanied not only by oxidation of the metal, but also by the formation of a brittle, gas-saturated surface layer whose thickness depended on the heating temperature and duration. The amount of dissolved gases in the surface layer reached 5.9 at. % in sheets rolled in air, and 1.8 at. % in sheets rolled in vacuum. With the removal of the gas-saturated layer, the elongation of the sheets rolled in air increased from 15 to 25%. But even with complete removal of the gas-saturated layer, the ductility characteristics of the metal were 10 to 20% lower than those of the vacuum-heated and rolled metal. For example, sheets heated and rolled in the air with a 0.9 mm surface layer removed had, after annealing at 1200°C for ½ hr, an elongation of 36% and a reduction of area of 65%, compared with 39.6 and 68% for identically heat-treated sheets rolled in a vacuum of 266.6×10^{-5} n/m^2. Thus, heating and rolling niobium in a vacuum of 266.6×10^{-5} n/m^2 at 1000 to 1300°C fully protected the metal from contamination with active gases, and ensured higher plastic properties. (JPRS)

15196 SPIN-DISORDER RESISTIVITY MEASUREMENTS IN Gd–Y ALLOYS. Popplewell, J.; Arnold, P. G.; Davies, P. M. (Univ. Coll. of North Wales, Bangor). Proc. Phys. Soc. (London), 92: 177-82(Sept. 1967).

Resistivity measurements were made on a number of Gd–Y alloys at 4.2 to 1100°K. The exchange coupling constant J was calculated from the spin-disorder resistivity and found to vary from 2.1 ± 0.1 eV $Å^3$ in pure gadolinium to 6.0 ± 0.04 eV $Å^3$ in an alloy containing 10.1 at. % gadolinium. In order to interpret this concentration dependence of J, covalent mixing between the localized 4f electrons and the conduction electrons at the Fermi surface was assumed. (auth) (UK)

15197 THE SOLUBILITY OF HYDROGEN IN TRANSITION METALS AND ALLOYS. Ebisuzaki, Y.; O'Keeffe, M. (Arizona State Univ., Tempe). Progr. Solid State Chem., 4: 187-211(1967).

It is stated that, despite the large amount of data available on the interaction of metals with hydrogen, little by way of a unifying principle has emerged. Recent developments in the theory of transition metals, and the advent of techniques such as neutron spectroscopy and nuclear magnetic resonance, have provided much new information in this field; these recent results are reviewed and an attempt was made to use them in a reevaluation of the chemical data. Discussion is mainly restricted to very dilute solutions in which the hydrogen may be considered randomly distributed, and in which complications such as the formation of new phases do not occur. It was found that the experimental results can be interpreted in terms of a "screened potential model." The same model would appear to be equally applicable to hydrides. Headings are as follows: Interstitial hydrogen in metals; thermodynamics of solution; isotope effects; transition metals; nature of dissolved hydrogen in metals; calculation of heat of solution; experimental data-elements; discussion of data (alloys, hydrides). 94 references. (UK)

15198 RESISTANCE AND CRYSTAL STRUCTURE OF CERIUM AS DETERMINED BY TEMPERATURE CYCLING. Major, R. W.; Leinhardt, T. E. (Virginia Polytechnic Inst., Blacksburg). J. Phys. Chem. Solids, 28: 1669-72(Sept. 1967).

Simultaneous measurements of electrical resistances and crystal phase fractions of two samples of cerium were made near 300, 80, and 10°K. The samples were cycled over this temperature range several times. The quantities of Ce-α and Ce-γ present in the samples during the first cycles decreased in succeeding cycles; the Ce-β contents increased. During the first two or three cycles changes in the resistances roughly followed changes in the amounts of Ce-γ present in the samples. As the cycling proceeded, the resistances and crystal phase fractions tended to fluctuate about mean values. (auth) (UK)

15199 SOME MATHEMATICAL CONSIDERATIONS RELATING TO THE SAGGING OF BARS OF UNIFORM CIRCULAR CROSS SECTION. Slattery, G. F.; Miller, W. N. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Nucl. Eng. Design, 6: 342-4(1967).

In order to estimate creep parameters from sagging bar tests, a creep modulus F has been defined, by analogy to elastic moduli, such that $F = \sigma^n/(d\epsilon/dt)$ where σ is the stress, ϵ is the strain, t is the time and n is a constant. A mathematical analysis has been made of this relation leading to a general form of bending moment equation. Expressions are derived for particular values of n which relate the sagging rates of the mid-points of end supported uranium bars to the creep modulus F. The expressions are used in experimental determinations of the parameter n from sagging bar tests carried out on uranium. (auth)

15200 SEGREGATION AND INCLUSIONS IN ZIRCONIUM-CONTAINING MAGNESIUM CASTING ALLOYS. Lagowski, B. Mod. Cast., 52: No. 2, 87-114(Aug. 1967).

Various types of inclusions and segregation, which can be detected radiographically, are illustrated, including hot tears, pipe shrinkage and microshrinkage resulting from eutectic enrichment, segregation resulting from eutectic depletion, gravity segregation, insoluble compounds, oxide films, sand inclusions and several unidentified types of inclusions. Effects of these defects on the ultimate tensile strength, yield strength, elongation and other mechanical properties of several different Mg-alloy castings are given. Mechanisms for the formation of these defects are correlated with radiographic appearance and radiographic standards used for these defects by various companies are listed. Recommendations are put forward for establishing a research program to investigate the effect on properties of hot tear type eutectic segregation, gravity type segregation of Zn-Zr compounds and sand particle inclusions. It is proposed that hot tear pipe shrinkage and microshrinkage types of eutectic enrichment be accepted in castings for elevated temperature applications and that light microshrinkage eutectic enrichment and any degree of eutectic depletion be accepted in castings for use at room temperature. Oxide film inclusions should not be accepted in any stress-carrying parts of castings. (Rev. Metal Lit.)

15201 DIFFUSION OF CARBON IN CARBIDES OF THE TRANSITION METALS. IV. VI GROUP OF THE PERIODIC SYSTEM. Andrievskii, R. A.; Eremeev, V. S.; Zagryazkin,

V. N.; Panov, A. S. Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 2158-64(Dec. 1967). (In Russian).

The diffusion of C in the carbides of Zr, Mo, Ti, Hf, and V was investigated using ^{14}C. The difference in results of the study of diffusion during saturation of the metallic or carbide samples with non-uniform concentration of C and data from the study of diffusion using ^{14}C are related to the effects of thermodynamic factors. The variation of these factors and the partial configuration entropy were evaluated in the first approximation in relation to the stoichiometry. The values of the activation energy for the diffusion, determined in the study, were compared with the heats of sublimation and the heats of formation of the carbides. (tr-auth)

15202 SURFACE SELF DIFFUSION ON TUNGSTEN BY THE MASS TRANSFER METHOD. Ho-yi, Lai (Royal Inst. of Tech., Stockholm). Jernkontorets Ann., 151: 801-21(1967).

Measurements of the rate of multiple-scratch smoothing and the thermal grooving of grain boundaries were made on polycrystalline specimens of tungsten. The specimens were heated in dry hydrogen at 1600, 1800, 2000, 2200, and 2300°C. The results show that surface diffusion is the predominant mechanism. The result self-diffusion coefficient D_s averaged over all orientations and measured by the multiple-scratch smoothing technique, obeys the equation $D_s = D_0 \exp(-Q_s/RT)$ with $Q_s = 53{,}200$ cal/mol and $D_0 = 0.2$ cm^2/sec. The diffusion coefficient obtained by the grain boundary technique is in agreement with the above equation except for 2200 and 2300°C where it is lower. The orientation dependence of D_s was studied by the multiple-scratch smoothing technique. It was found that D_s is markedly dependent on surface orientation; the smallest D_s was obtained near the (100) region and the largest near the (111) region. The variation of D_s with surface orientation is independent of temperature, and the activation energy Q_s is thus the same for all orientations. (auth) (Sweden)

15203 EFFECT OF SURFACE CONDITION AND TEMPERATURE ON THE TOTAL HEMISPHERICAL EMITTANCE OF PLUTONIUM. Seery, W. N. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Nucl. Mater., 25: 64-8 (1968).

Heat transport by radiation between a plutonium sphere and surrounding black-body surface was studied over a range of temperatures and surface conditions to evaluate the emittance of plutonium. The emittance of plutonium was found to increase slowly with increasing temperature over the range from 200 to 500°K. The emittance of plutonium at constant temperature was found to decrease by a factor of two from a machined surface to a highly polished surface. The effect of surface oxidation on the emittance of plutonium was also investigated. (auth)

15204 METALLOVEDENIE TUGOPLAVKIKH METALLOV I SPLAVOV. (Metallography of Refractory Metals and Alloys). Savitskii, E. M.; Burkhanov, G. S. Moscow, Izdatel'stvo Nauka, 1967. 324p.

A brief review is given on the physico-chemical properties of high-melting metals. Natural resources and methods for preparing high-melting metals, interatomic bond, crystalline structure, and basic physical properties of high-melting metals are discussed. Physico-chemical reactions of high-melting metals with other elements, the problems of cold brittleness of the metals and alloys, and high-melting metal and alloy monocrystals are discussed. Data on the phase diagrams constructed for Cr, Hf, Nb, La, Re, Rh, Ru, Os, Pa, Ta, Ti, V, W, and Zr base alloys and means for corrosion protection of metals and alloys are included. Metallurgy, including melting, casting, welding, and extrusion treatment of the high-melting metals and alloys is covered. (199 references.) (R.V.J.)

15205 DISPERSION FUEL ELEMENTS. An AEC Monograph. Holden, A. N. Monograph Series on Metallurgy in Nuclear Technology. New York, Gordon and Breach, Science Publishers Inc., 1968. 255p. $11.00. (TID-24246).

A review of dispersion nuclear fuels including history, theories, and fabrication processes is presented. The technology of aluminum base, stainless steel base, graphite base, and oxide base dispersion fuels is presented regarding mechanical and physical properties. Research on refractory metals is reported. The effects of radiation on dispersion fuels and the metallography and examination of dispersion fuels are given. (J.C.W.)

15206 ALKALI METAL HANDLING AND SYSTEMS OPERATING TECHNIQUES. An AEC Monograph. Mausteller, J. W.; Tepper, F.; Rodgers, S. J. Monograph Series on Nuclear Science and Technology. New York, Gordon and Breach, Science Publishers Inc., 1967. 241p. $10.50. (TID-24247).

Aspects of the technology of alkali metals as heat transfer agents are discussed. Information is included on design and operation of liquid-metals systems, purification analysis, the role of oxygen and other atmospheric contaminants in corrosion, materials compatibility, instrument and component development, and safety procedures. Data are included on the physical properties of Li, Na, K, Rb, and Cs. (J.C.W.)

Structure and Phase Studies

Refer also to abstract 15198.

15207 (CALT-221-39) EXPERIMENTAL CONFIRMATION OF THE LIFSHITZ-WAGNER THEORY OF PARTICLE COARSENING. Research and Development Report No. 54. Ardell, A. J. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Feb. 1968. Contract AT(04-3)-221. 28p. Dep. CFSTI.

Various aspects of the Lifshitz-Wagner theory of particle coarsening are examined using data on the γ' precipitate in binary Ni-base alloys of Al, Ti, and Si. The kinetics of growth of the average particle, the experimental distributions of particle sizes, and the variation with time of the average solute concentration of the matrix are all demonstrated to be in excellent quantitative agreement with the predictions of the Lifshitz-Wagner theory. A small discrepancy between the experimental and theoretical values of the cut-off particle size (the largest particle size observed in the distribution) is briefly discussed. A kinetic equation for the variation of the volume fraction γ' during coarsening is presented. Data on the Ni-Al system are used to illustrate the change in volume fraction that accompanies coarsening of the γ' precipitate. (auth)

15208 (IS-T-219) REFRACTORY METAL-CARBIDE SYSTEMS. Tosdale, Jack Paul (Ames Lab., Iowa). May 1967. Contract W-7405-eng-82. 100p. Dep. CFSTI.

Thesis.

Melting points and lattice parameters were measured for compositions in the following systems: TaC-ZrC, TaC-HfC and NbC-ZrC-UC. Preliminary phase studies were done on the Ta-C system near the monocarbide stoichiometry to determine the effect of carbon vaporization, at high temperatures, on the melting point. The oxidation resistances of ternary solutions of NbC-ZrC-UC were also measured. The experimental techniques for determining the melting points and lattice parameters are described along with some theory on the optical pyrometry used in the melting point determinations. All of the systems studied displayed complete solid solubility at room temperature. In the two binary systems, both the solidus curves and the lattice parameter-composition curves varied somewhat negatively from linearity. The solidus surface of the NbC-ZrC-UC ternary system tends to curve above a plane drawn through the melting points of the components represented in elevation at the three apexes of an equilateral triangle. The lattice parameter-molar composition surface contained a slight negative deviation from a plane passed through the lattice parameters of the individual carbides in a triangular space diagram. The oxidation resistances of binary mixtures of UC and NbC or ZrC were increased by the addition of the third component. (auth)

15209 (MLM-1381(tr)) THE CARBONYL PROCESS AND THE EVAPORATION PROCESS FOR THE DETERMINATION OF PHASE EQUILIBRIA IN THE TEMPERATURE RANGE OF LOW MOBILITY, WITH IRON-NICKEL ALLOYS AS EXAMPLE. Heumann, Theo; Muenster, Gerhard Karsten. Translated for Mound Lab., Miamisburg, Ohio, from Arch. Eisenhuettenw., 34: 781-5(1963). 24p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Processes are described, which make possible the establishment of equilibria of alloy phases in a temperature range where diffusion no longer takes place. The first uses gaseous carbonyls of iron and nickel in various proportions. The gaseous mixture is decomposed on a suitable carrier at the desired temperature. It is possible in this way to arrive at equilibria between 230 and 360°C. In the second procedure the components of an alloy melt are allowed to evaporate and the mixed vapors are condensed on a suitable collector. The latter procedure, in the case of iron-nickel alloys, leads to equilibrium only above approximately 370°C. The results show that the alloys of the γ phase decompose. The eutectoid equilibrium, γ (52 atom % Ni) $\rightarrow \alpha_1$ 6.5 atom % Ni + ($FeNi_3$) (62.5 atom % Ni) is at 345°C. Above this temperature, the values agree fully with those of Owen and co-workers. (auth)

15210 INITIAL STAGES OF DISINTEGRATION OF Co-Ta AND Co-Nb SUPERSATURATED SOLID SOLUTIONS. Kokorin, V. V.; Chuistov, K. V. Phys. Metals Metallogr. (USSR) (Engl. Transl.), 21: 163-7(1966).

The changes in crystal structure which occur in the initial stages of decomposition of supersaturated solutions of Co-8 wt % Ta and Co-4 wt % Nb were studied by x-ray analysis. Both coarse-grain specimen and powder methods were used. The former were studied by x-raying the specimens in special Laue cameras. The

specimens had a cylindrical form 0.6 to 0.8 mm in dia. The gap between the specimen and the film was 40 to 50 mm. Mo, Ni, Co, Cu, Fe and Cr radiation was used. Fine-grained specimens were studied on an x-ray apparatus equipped with scintillation registration of x-ray beam scattering. Specimens were in the form of flakes or platelets 1 to 1.5 mm thick. Coradiation was used. After water quenching at 1200°C, the Co–Ta and Co–Nb specimens were aged at 500 to 900°C, holding at each temperature for 1 hr. The course of the decomposition was checked according to changes of the average parameter of the crystal lattice of the initial alpha-solid solution and according to changes in hardness. It appears that precipitation of the excess phase during decomposition of Co–Ta alloy occurs from 750 to 800°C and in Co–Nb, at 650 to 750°C. To study decomposition in the initial stages, 750°C was chosen for Co–Ta and 700°C for Co–Nb. Areas of abnormal scattering were plotted. In the initial decomposition stages of both alloys, lamellar or plate-like areas are formed which are both enriched and impoverished by alloying elements. These areas are located on the planes of the cube of the crystal lattice of the initial alpha-solid solution. (Rev. Met. Lit.)

15211 STUDY OF EQUILIBRIUM PHASES IN THE Ni–Cr–Ti–Al–W SYSTEM. **Havalda, Andrej (Slovenska Akademia Vied, Bratislava). Kovove Mater., 5: 3-23(1967). (In Slovak).**

Investigation of the NiCrTiAlW system at 850°C within a 0 to 15-at. % range of tungsten content and with various Ti/Al ratios is reported. A phase analysis of 101 alloys annealed to the equilibrium state at 850°C was conducted using optical and electron microscopy as well as x-ray analysis. Results indicate that in addition to the permanent η and γ' phases present in the solid solution of nickel, there exists an α-phase which represents the tungsten-based solid solution. This phase is stable even at the temperature of 850°C, whereas the Ni_4W phase has not been observed at this temperature. On the basis of these results it is concluded that the range of the α-phase in the quinternary system increases toward lower temperatures. The solubility of nickel in the α-phase is determined to be 2%. (IAA)

15212 DETERMINATION OF OMEGA PHASE MORPHOLOGY IN Ti–35 PERCENT Nb BY TRANSMISSION ELECTRON MICROSCOPY. **Brammer, W. G. Jr.; Rhodes, C. G. (North American Aviation Science Center, Thousand Oaks, Calif.). Phil. Mag., 16: 477-86(Sept. 1967).**

Considerable data on the x-ray diffraction analysis of omega phase in titanium alloys have been reported, but little direct observation of its occurrence by electron microscopy has been described. It was demonstrated by means of transmission electron microscopy that the omega phase in titanium–35% niobium precipitates as ellipsoids. By means of dark-field and selected area diffraction microscopy, stereographic projections could be constructed which indicate that the major axes of the ellipsoids (the [0001] crystallographic direction) are parallel to [111] directions in the matrix. (UK)

15213 IRON–TUNGSTEN SYSTEM. **Sinha, A. K.; Hume-Rothery, W. (Oxford Univ.). J. Iron Steel Inst. (London), 205: 1145-9(Nov. 1967).**

The Fe–W equilibrium diagram was determined in the range from 0 to 45 at. % W by a combination of thermal analysis and microscopical, x-ray, and dilatometric methods. The iron-rich liquidus and the α-solidus pass through a minimum at 1,529°C and 4.4 at. % W. There is a peritectic horizontal at 1548°C, where the α-phase (14.3 at. % W) forms from the liquid (11.2 at. % W) and the μ-phase. The μ-phase (39.8 at. % W) is formed peritectically at 1,637°C. The γ-loop was established dilatometrically and extends to 1.26 at. % W. Lattice parameter measurements on the α-solid solution containing up to 8 at. % W were made. The Laves phase $Fe_2W(\lambda)$, having the $MgZn_2$ type structure, is formed at 1,060°C as a result of a sluggish peritectoid reaction. The existence of the μ-phase at 39.1 to 40.5 at. % W was confirmed; its crystal structure is of the $D8_5$ type, and is based upon Fe_7W_6. The lattice parameters of the intermediate phases were determined, and their structural characteristics are described. (auth) (UK)

15214 DISLOCATION RELAXATIONS IN SINGLE-CRYSTAL AND POLYCRYSTALLINE NIOBIUM AND TANTALUM AT MEGAHERTZ FREQUENCIES. **Mitchell, O. M. Mracek. J. Acoust. Soc. Amer., 41: 1058-62(Apr. 1967).**

Maxima in the attenuation of longitudinal ultrasonic waves (10 to 60 MHz) as a function of temperature due to a dislocation-relaxation mechanism have been observed in plastically compressed single-crystal Nb and polycrystalline Ta in the temperature range 150 to 400°K. In single-crystal Nb with the wave propagation in a [110] direction, the peak at 10 MHz is at 318°K and at 30 MHz is estimated to be at 370°K. In polycrystalline Ta, the peak at 10 MHz is at 29°K. The peaks are unstable at temperatures above 350°K, where a low-temperature recovery takes place. The peaks at megahertz frequencies have widths approaching the theoretical values for a single-relaxation process. The peak temperatures and frequencies are compared in Arrhenius plots for Nb and Ta to data for the alpha peaks for a wide range of frequencies. (Rev. Metal Lit.)

15215 SOME ADVANCES IN THE STRUCTURAL CHEMISTRY OF ALLOYS (T-X AND T-M-X PHASES). **Nowotny, H. Freiberg. Forschungsh. B., 123: 7-26(1967). (In German).**

A review of the structures of various solid-phase metal alloys and compounds is presented. The monocarbides, (TiC, HfC, VC and ZrC) have great importance due to their high electrical conductivity and common occurrence. Their electronic structure and magnetic properties are discussed along with those of the mononitrides. The lattice parameters of carbohydrides (Ti, Zr, Hf, V, Y or $La)_2C_xH_y$ and subcarbides (V_2C) are given and H_2 solubility is discussed. Other structures discussed include perovskite carbides and nitrides, beta-Mn, Cr_2AlC, n-carbides, Mn_5Si_3, $Mn_{11}Si_{19}$ and disilicides. (Rev. Metal Lit.)

15216 ON THE ORIGIN OF AN ANOMALOUS THERMAL ARREST WITHIN THE β RANGE IN URANIUM. **Rodriguez, C.; Kittl, J.; Coll, J. A.; Marcone, N. (Comision Nacional de Energia Atomica, Buenos Aires). J. Nucl. Mater., 25: 119-24(1968).**

The anomalous thermal arrest in quenching of uranium produced under the same experimental conditions as in previous investigations, was studied and metallographic and microprobe investigations of the samples were carried out. The results indicated that anomalous thermal arrest is a spurious effect that arises from a contamination of the samples. (M.C.G.)

15217 EXTENDED DISLOCATIONS AND STACKING FAULTS ON (110) AND (001) PLANES OF α-URANIUM. **Saxl, I.; Kocik, J.; Otruba, J. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). J. Nucl. Mater., 25: 108-13(1968).**

The splitting and stability of the dislocations in the $(1\bar{1}0)$ plane of α-uranium are considered. Certain dissociations suggested by geometrical considerations are put forward, and these are checked by calculating the forces between the partials using both isotropic and anisotropic elasticity. (M.C.G.)

15218 EXPANDABILITY TEST ON BERYLLIUM TUBE TO BE USED FOR FUEL CLADDING OF NUCLEAR POWER REACTORS. **Mishima, Yoshitsugu (Tokyo Univ.); Maruyama, Akira Sogo Shikensho Nempo, 25: 149-56(Dec. 1966). (In Japanese).**

Development of a device to measure the tangential elongation of a Be tube used for fuel cladding is described. A lead insert 20 to 25 mm long contained in the specimen tube is compressed, producing the even expansion through a considerable length of the tube. Tests were carried out by this apparatus on Be tubes produced by various processes of fabrication. About 3% tangential elongation at 200°C was obtained with Be tubes produced by powder metallurgy, which are usually considered to acquire no elongation at low temperatures. The 0°-direction extruded tube with a slight elongation had a sharp [1010] fibrous figure, whereas the one with a large elongation, although near the [1010], was dispersed. Dispersing as much as possible in the bottom direction may increase the tangential elongation. (NSA of Japan)

15219 THE STRUCTURE OF SURFACES. **Proceedings of the Symposium held at Durham, North Carolina, November 8–9, 1966. Surface Sci., 8: 1-265(1967). (CONF-661132).**

A total of 17 papers was presented at the symposium. A separate abstract was prepared for each of six papers. One paper on He ion microscopy was previously abstracted in NSA. The papers for which no abstracts were prepared are concerned with electron diffraction, Au surface structures, copper–oxygen reactions, Al surface interactions, and methods for surface examination. (J.R.D.)

For abstracts of individual papers see: 15192, 15193, 15220–15222, and 15227.

15220 SURFACE ASYMMETRY MECHANISM FOR FRACTIONAL ORDER PEAKS OBSERVED IN LEED BEAMS FROM METALS. **Gerlach, R. L.; Rhodin, T. N. (Cornell Univ., Ithaca, N. Y.). Surface Sci., 8: 1-13(1967).**

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

The occurrence of fractional order peaks in the intensity vs. wavelength relationship for individual diffraction beams in low energy electron diffraction (LEED) patterns from single crystal surfaces of copper, nickel, and tungsten is discussed. An analysis based on a kinematic viewpoint modified to include effects of the asymmetric interaction of electrons at the surface is presented and shown to be in agreement with observations on clean surfaces.

In addition, an interpretation consistent with this approach of how small coverages of metallic atoms and electronegative gases might reduce the intensity of the fractional order peaks is discussed. The approach is related to that originated by Khan, Hobson, and Armstrong. (auth)

15221 OXIDATION OF THE (112) FACE OF TUNGSTEN. Chang, C. C.; Germer, L. H. (Cornell Univ., Ithaca, N. Y.). Surface Sci., 8: 115-29(1967).

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

Electron diffraction studies of a W(112) face have shown that the surface atoms have the normal arrangement for this crystal plane. When exposed to oxygen at room temperature a $p(2 \times 1)$ structure develops with the double spacing along the close packed rows of surface atoms. This structure covers the entire surface when the oxygen exposure reaches 10^{-6} Torr sec, the sticking probability decreasing from an initial value of almost unity to a final value of about 0.4. With further exposure the $p(2 \times 1)$ structure is replaced gradually by a $p(1 \times 2)$, representing a double spacing normal to the close packed rows. If the crystal is not heated, this $p(1 \times 2)$ structure persists to very high oxygen exposures. But if the crystal is heated after high oxygen exposures, complex structures of the form $p(1 \times n)$ are formed, with n = 1, 2, 3 or 4. Heavy exposure to oxygen (e.g., 10^{-4} Torr sec) while hot produces a structure, which is shown to be made up of (110) facets. The other $p(1 \times n)$ structures, including the $p(1 \times 2)$ formed at room temperature, may perhaps be made up of incipient (110) facets. All of these complex structures can be degraded in a good vacuum to form a $p(2 \times 1)$ structure at 2050°K and finally a clean (and unfaceted) surface at about 2100°K. (auth)

15222 INELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM SURFACES. Scheibner, E. J.; Tharp, L. N. (Georgia Inst. of Tech., Atlanta). Surface Sci., 8: 247-65(1967).

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

The method of energy analysis of back-scattered electrons has been applied in studies of single crystal surfaces of tungsten, graphite and copper for primary electrons in the range of 30 to 350 eV. Information obtained by this method on the various inelastic processes, coupled with low energy electron diffraction (LEED) patterns from the same surfaces, provides additional understanding of the scattering of electrons in the low energy range. The identification of peaks in energy distribution curves due to the excitation of bulk and surface plasma resonances in tungsten is made. The energy distributions for all three materials show additional features attributable to single electron interband transitions and Auger transitions. For copper the energy loss measurements are correlated with the optical reflectivity data of Ehrenreich and Philipp. (auth)

Radiation Effects

Refer also to abstract 15141.

15223 (CONF-670924-3) ELECTRICAL RESISTIVITY STUDIES OF THE RECOVERY OF POINT DEFECTS IN FCC METALS FOLLOWING ELECTRON IRRADIATION. Snead, C. L.; Wiffen, F. W.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). [1967]. 18p. Dep. CFSTI.

From International Conference on Solid State Physics Research with Accelerators, Upton, N. Y.

Stage I recovery of electron irradiated copper, silver, and gold was examined. The behavior of all three can be explained by the same model. Stage I is due to the annihilation of interstitials at vacancies. Most of stage I is due to the collapse of close Frenkel pairs but a small amount of the end of stage I represents the random migration of interstitials to vacancies. Free interstitial migration is seen near 47°K in copper, near 31°K in silver, and is suspected to occur at about 21°K in gold. The amount of recovery due to free interstitial recombination with vacancies decreases in the order copper to silver to gold. It has not yet been possible to positively identify a free migration process in gold. The range of the interstitial interaction increases in going from copper to silver to gold. This makes impurity-interstitial and interstitial-interstitial processes more important at the expense of the interstitial-vacancy recombination. It is manifest in a decreasing I_E (free interstitial migration to vacancies) in going from copper to gold. The result is that in gold most interstitials are tied up before they can reach vacancy sinks. In silver and copper this competition for freely migrating interstitials results in less than 100% recovery in stage I. In the copper where the free migration substage is large enough to be studied the recovery kinetics are complex, due to the three processes competing for the mobile interstitials. For any one of the three metals the composition between interstitial annihilation, dimer formation and impurity trapping results in a concentration dependence of the amount of stage I recovery. (auth)

15224 (COO-1367-16) EFFECT OF ELECTRON IRRADIATION ON PLASTICITY OF METALLIC SINGLE CRYSTALS. Ono, Kanji (California Univ., Los Angeles); Meshii, M. (Northwestern Univ., Evanston, Ill.). Aug. 1, 1957. Contract AT(11-1)-1367. 22p. (CONF-670924-4). Dep. CFSTI.

From International Conference on Solid State Physics Research with Accelerators, Upton, N. Y.

Electron irradiation hardening in Al–Zn alloy is discussed and the observed alloying effects between Al and Cu are given. The effects of electron irradiation on work hardening behavior of Al are discussed in terms of various theories. (F.S.)

15225 (GEMP-1002, pp 38-64) RADIATION EFFECTS ON FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Moteff, J.; Kingsbury, F.; Smith, J. P. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Creep-rupture tests at 650°C on Hastelloy X have shown the same reduction of properties regardless of whether the specimens were irradiated in the ETR or EBR-II to fluences of 0.5 to 3×10^{20} n/cm^2 ($E_n \geq 1$ Mev). Incoloy 800, irradiated to 3×10^{20} n/cm^2 ($E_n \geq 1$ Mev) and tested at 705°C, shows about a factor of two decrease in minimum creep rate compared to unirradiated material. This change in creep rate is accompanied by a factor of 2 decrease in elongation at fracture and a factor of 1.5 increase in rupture life. Hastelloy R-235 which had been re-solutioned and re-aged following 70°C irradiation exhibited about one-half the as-irradiated rupture life at 870°C. Analysis of creep data for A-286, containing two different B levels and irradiated to various thermal neutron fluences, showed that the reduction in the minimum creep rate is directly related to He formed from the $^{10}B(n,\alpha)^7Li$ reaction. The increase in stress dependency, n, ($\dot{\epsilon} \approx \sigma^n$) appears to be independent of He concentration, however, and is constant over the range of irradiation conditions examined. Transmission electron microscopy observations of irradiated Hastelloy R-235 reveal the presence of circular halos of dislocations surrounding selected carbide particles. These duplex halos consist of an outer halo with an approximate radius of 3 microns and a central halo of 1 to 1.5 microns radius. These distances are approximately equal to the α particle and Li atom recoil distances in Ni. The effect of post-irradiation annealing on the 700°C creep-rupture properties of irradiated Mo (1.1×10^{20} n/cm^2, $E_n \geq 1$ Mev) has been continued on a series of specimens containing a factor of eight greater C (~200 ppm) content than the previously reported series. Results confirm that an annealing temperature of greater than 900°C is necessary to remove the incubation period for delayed creep, and that a 1200°C anneal, although eliminating the incubation period, does not restore the properties to control values. The data suggest an effect similar to thermal hardening, with the formation of stable defects at temperatures between 900° and 1200°C. Initial results of the effects of post-irradiation annealing on the room- and elevated-temperature properties of irradiated Nb sheet (2.1×10^{20} n/cm^2, $E_n \geq$ 1 Mev) show no indication of thermal hardening. A 1-hour anneal at 1000°C was required for complete recovery to unirradiated values, compared with a 600°C anneal reported previously on material irradiated to a lower fluence. Hot-microhardness data were determined for Mo–0.5Ti, Ta, Ta–10W, and 306 alloy (W–30Re–30Mo, at. %), from 25° to 1200°C. A comparison of 256 alloy (W–25Re–30Mo, at. %) hardness and 306 alloy hardness showed the 256 alloy to be harder in the 850° to 1300°C temperature range, a result consistent with the modulus difference between W and Re in the two temperature ranges. A comparison was made of the Mo–0.5Ti data with previous Mo and Mo-TZM data. Radiochemical analysis of ninety-three Fe, Ni, and Ti dosimeters has allowed the preliminary fast-flux mapping of EBR-II rows 2 and 7 positions. Good agreement was obtained between the three types of dosimeters used in the investigation. (auth)

15226 (ORNL-TM-2059) THE PROGRAM OF THE RADIATION METALLURGY SECTION, SOLID STATE DIVISION, OAK RIDGE NATIONAL LABORATORY. Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 49p. Dep. CFSTI.

Radiation damage and radiation hardening and embrittlement in the body-centered cubic metals are discussed. The problem of the radiation embrittlement of pressure vessel steels and the applied aspects of the problem are under investigation. The research covers work on commercial steels, iron and iron alloys, and refractory metals. The significance of the research and its bearing on materials problems in nuclear technology are discussed. (auth)

15227 INVESTIGATION OF SURFACE BOMBARDMENT DAMAGE BY LEED. Farnsworth, H. E.; Hayek, K. (Brown Univ., Providence). Surface Sci., 8: 35-56(1967).

From Conference on Structure of Surfaces, Durham, N. C. See CONF-661132.

Atomically clean and annealed Mo(001) and (110) and W(110) surfaces were bombarded with Ne^+, Ar^+, Kr^+ or Xe^+ ions and the effects were observed by low energy electron diffraction (LEED). Degradations determined from peak intensities were observed as a function of ion dosage and energy in the range 25 eV to 1000 eV. Only beams characteristic of the bulk spacings were observed from the clean annealed surfaces. The number of diffraction peaks in these beams exceeded the number which can be associated with Bragg reflections from crystal planes, the extra peaks being generally less intense. Some of the major peaks fell below the voltages of the Bragg reflections, while others fell at or near these values. The 112 peak from (001) Mo and 211 peak from (110) Mo were absent or very weak for the clean annealed surfaces. These peaks at the Bragg voltages were developed remarkably by ion bombardment. The minor peaks were degraded more rapidly by bombardment than the major peaks. Some major peaks occurring below the Bragg voltages appeared to be shifted toward these voltages as they became degraded by bombardment. Others became degraded with little or no shift in voltage, while adjacent peaks at the Bragg voltages became relatively more intense. Thus some peaks were present after saturation dosages. None of the peaks remaining after bombardment indicated faceting parallel to other planes. That these peaks resulted from a roughening of the surface is indicated by the observation that the intensity distribution produced by ion bombardment was similar to that obtained by heating an oxygen covered surface. In the latter case the evaporation of a molybdenum oxide caused a roughened surface. Using the procedure of Jacobson and Wehner, the mean area of damage per incident ion was observed to be approximately 0.6×10^{-15} cm^2/ion at 50 eV for both Ne^+ and Xe^+ and at 1000 eV, 25×10^{-15} cm^2/ion for Ne^+ and 9×10^{-15} cm^2/ion for Xe^+. Bombardment of (001) Mo with N^+ ions caused a more rapid extinction of all beams than that caused by bombardment with inert gas ions. Patterns from both surfaces of bombarded Mo were restored by heating at 600 to 650°C, independent of bombardment energy and dosage. (auth)

15228 CREEP OF THORIUM DURING FISSION. Holmes, J. J.; Petersen, L. O. (Atomics International, Canoga Park, Calif.). Phil. Mag., 16: 845-8 (Oct. 1967).

Creep of Th was measured during fission induced by bombardment with 35 MeV protons. Fission was found to affect creep by greatly inhibiting normal creep mechanisms and by providing an additional deformation mechanism associated with the fission spike. (auth) (UK)

15229 STUDIES IN RADIATION EFFECTS ON SOLIDS, VOLUME II. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, 1967. 312p. $19.50 Reference Edition, $12.50 Professional Edition.

Three sections on the effects of radiation on solids are presented. A separate abstract was prepared for each section. (J.C.W.)

For abstracts of individual sections see: 15230, 15231, and 15263.

15230 EFFECTS OF RADIATION ON RATE PROCESSES IN ALLOYS. Damask, A. C. (City Univ. of New York. Brookhaven National Lab., Upton, N. Y.). pp 1-106 of Studies in Radiation Effects on Solids. Vol. II. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The effects of various bombarding particles on alloys include destruction of order, breakup of precipitates, enhanced nucleation, retarded shear transformation, enhanced and retarded diffusion, homogenization, and the rare gas effects. The disordering effect is studied for Cu–Cu and Mn–Ni alloys. The procedure for measuring the breakup of precipitate particles of the Cu–Fe system is described. The Co–Cu system exhibits unique phenonena associated with the presence of precipitate particles. Observations of diffusion enhancement are discussed for the Cu–Zn, Al–Cu, Fe–Si, Tc–Ni, and Cu–Ni systems. Quenched carbon–iron was irradiated at 175°K in a fast flux of 10^{11} nv. Nucleation enhancement in Fe–N and during the precipitation of carbon in alpha-ion is discussed. Homogenization of Mo–U alloys is reported. (J.C.W.)

15231 THERMAL DECOMPOSITION OF IRRADIATED MATERIALS. Jach, Joseph (State Univ. of New York, Stony Brook). pp 107-58 of Studies in Radiation Effects on Solids. Vol. II. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, 1967.

The technology of decomposition of normal unirradiated solids is reviewed and theories and experiments on the decomposition of irradiated solids and the effects of radiation on the decompositions are discussed. Information on thermal decomposition of Ba and Pb azides, Ni and Ag oxalates, K permanganate, and Na and K bromates is presented. (J.C.W.)

Ceramics and Cermets

Refer also to abstract 16168.

15232 (ORNL-P-3595) MORTAR MODELS OF PRESTRESSED CONCRETE REACTOR VESSELS. Corum, James M.; White, Richard N.; Smith, Jack E. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 36p. (CONF-680203-2). Dep. CFSTI.

From American Society of Civil Engineers Transportation Conference, San Diego, Calif.

The results of the test of a small scale model of a prestressed concrete reactor vessel are presented. Model design and fabrication techniques are discussed, and the test results are compared with finite element analysis predictions for both elastic and short-term creep behavior. The test reported is the first of a series in a model study program being carried out to determine the usefulness of small mortar models and models of elastic materials, such as epoxy, in investigations of stress distributions and the cracking and ultimate failure mode of prestressed concrete reactor vessels or of various components of these vessels, such as penetration and anchor regions. (auth)

Corrosion and Erosion

Refer also to abstracts 14470 and 15139.

15233 CORROSION OF NIOBIUM CARBIDE AT HIGH TEMPERATURES IN MEDIA OF COMMERCIAL-GRADE INERT GASES. Babad-Zakhryapin, A. A.; Kuznetsov, G. D.; Gert, L. M. Zashch. Metal., 3: 233-4(1967). (In Russian).

Specimens of sintered NbC containing 11.1% bonded C and 1.2% free C were annealed in a vacuum of 6.10^{-5} mm Hg at 2300°C for 3 hr and tested for corrosion in He containing 0.3 and 0.01% N_2, respectively, and in Ar (0.01% N_2, 0.003% O_2, 0.03 $1/m^2$ water vapor), and of purified Ar (0.001% N_2, 0.001% O_2). The tests were made at 1300 to 2100°C at an ambient atmosphere pressure of 10 mm Hg. A layer of the reaction products that formed on the surface of the specimens increased in thickness with increasing temperature and with increasing content of impurities in He and Ar. At 1300°C, a carbide phase with a lower C content than in the initial carbide is formed on the surface. With increasing test temperature from 1300 to 2000°C, the lattice constant of carbide in the surface layer changed from 4.463 to 4.432 Å in the atmosphere of unpurified He. In unpurified Ar at 2000°C, the surface layer consisted of Nb_2C with a hexagonal lattice. Surface layers formed in unpurified He at 2000°C and in unpurified Ar at 1900°C had an identical phase composition which corresponded to the sequence of $NbC_{0.9}$ and NbC_x carbides. Depending on temperatures, the lattice constant of the fcc lattice of NbC_x varied from 4.42 to 4.44 Å. The test data showed that the surface decarburization is a result of the niobium carbide reaction with the impurities of the ambient atmosphere. The decarburization process involved mainly the reaction between the impurities and C, and the removal of the reaction products into the gas medium by vaporization. (ATD)

Preparation and Fabrication

Refer also to abstract 14739.

15234 (COO-1198-501) GROWTH OF TUNGSTEN CARBIDE MONOCRYSTALS. Gerk, Alvin Phillip (Illinois Univ., Urbana). Feb. 1968. Contract AT(11-1)-1198. 51p. Dep. CFSTI.

Thesis.

In research conducted to produce large WC crystals it was found that the size and quality of crystals grown from Co solutions during controlled slow-cooling depend on the melt composition and cooling rate. For lower concentrations of WC, the crystals are larger but of poorer quality. Slower cooling rates produce larger crystals at any composition. WC monocrystals one centimeter in size can be grown by a modified Czochralski technique. Cobalt is an effective solvent metal for use with this technique. Aluminum oxide crucibles have been used to contain the WC-Co melts with satisfactory results, but a reaction occurs between the melt and the crucible. Growth seeds may contain grain boundaries if cobalt has been removed from these boundaries. The seeds must be at least ¾ cm. in length, and the most favorable growth directions are the <0001> and <1100> directions. The quality of WC crystals is affected by the pulling temperature, melt composition, and the pulling and

rotation rates used. The highest quality crystals have been obtained using high pulling temperatures with low concentrations of WC in Co. Slow pulling rates (under 0.001 in./hr) and fast rotation rates improve crystal quality. Evidence obtained during these experiments indicate that the eutectic point in the WC-Co vertical section of the W–C–Co ternary phase diagram lies lower in concentration and temperature than previously reported. Also the liquidus line on the WC side of the eutectic lies higher in temperature. (auth)

15235 (UCRL–17978) ACTIVATED HOT PRESSING OF MAGNESIUM OXIDE. Hart, Patrick Eugene (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 78p. Dep. CFSTI.

Thesis.

The densification by pressure sintering of magnesium oxide compacts containing one-half to ten percent lithium fluoride was studied. This investigation gives insight into mechanisms involved in this fabrication process. Densification may be considered to be a three step process with the first two steps occurring in the fabrication die and the last step, annealing, being performed after pressing. The first stage in the die is a rapid process and is believed to be similar to the previously observed rearrangement stage. Depending on fabrication parameters, such as temperature, pressure, and initial lithium content, this initial stage may take place up to densities as high as 90% of theoretical, relative to pure magnesium oxide. Experimental evidence indicates that the final stage of densification in the die is controlled by flow of a lithium fluoride-rich phase along magnesia grain boundaries. Transport of magnesium oxide is by means of a solution-precipitation process. This analysis is valid for samples with densities between 91 and 99.5%. These two stages are separated by a transition or intermediate stage. The annealing stage is controlled by the evaporation of lithium fluoride from the sample surface. Samples having densities of 99.1% or more become transparent during annealing. (auth)

15236 (UCRL–70164) BEHAVIOR OF OXYGEN IN OXIDES DURING SINTERING. Condit, Ralph H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1968. Contract W-7405-eng-48. 22p. (CONF-670625–4). Dep. CFSTI.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y.

The need for studying details of the transport mechanisms during sintering is outlined. A technique for doing this is proposed which makes use of the nuclear activation of the rare isotope of oxygen, ^{17}O, so that it can be used in effect as if it were a radioactive tracer. A test of the feasibility of the use of this as a marker in the region of neck growth between grains of ceramic material is reported. (auth)

15237 (MLM–1475(tr)) PREPARATION OF TANTALUM NITRIDE BY MEANS OF NITROGEN PLASMA JET. Matsumoto, O.; Hayakawa, Y. Translated for Mound Lab., Miamisburg, Ohio, from Denki Kagaku, 34: 775-9(1966). 21p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A transport type plasma torch was used to produce tantalum nitride from metallic tantalum and nitrogen plasma. X-ray analysis revealed that the bulk of the product was the TaN that was sought. The characteristics of the torch along with the effect of some reaction conditions were investigated. Some speculations on the reaction mechanism were made. (auth)

15238 (MLM–1480(tr)) DIFFERENT METHODS OF SPHEROIDIZING. Bildstein, H. Translated for Mound Lab., Miamisburg, Ohio, from Ber. Deut. Keram. Ges., 41: 108-11(1964). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

This paper was abstracted from the original language and appeared in NSA as 18: 27929. (R.C.K.)

15239 CREEP-FEED PLUNGE GRINDING OF TUNGSTEN CARBIDE WITH DIAMOND CUP WHEELS. Amrhein, H. G. T Z Prakt. Metallbearb., 61: 1-6(Jan. 1967). (In German).

In the creep-feed plunge grinding of carbides the table performs a slow forward feed movement in place of the usual oscillation; the feed rate is 10-100 mm/min and the in-feed may be 0.1 to 3 mm. The peripheral velocity cannot exceed about 22 m/sec and only wet grinding is used. The remarkable results obtained with the method, which include, in addition to the high grinding rates, the series production of carbide tools with a tolerance around 2 microns, are based on fundamental design principles, of which the most important are the high rigidity and power required of the machine. The diamond wheels used possess a concentration of 100% and grain sizes of approximately 100 microns. The design principles of the grinding machines are presented in detail and the areas where further research is needed are outlined. (5 references.) (Rev. Metal Lit.)

15240 ACTIVATION SINTERING OF ZIRCONIUM AND HAFNIUM CARBIDES IN A VACUUM. Meerson, G. A.; Fekhretdinov, F. A.; Kopelkin, V. A. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater., 3: 2174-8 (Dec. 1967). (In Russian).

The preparation of dense samples (porosity of 3 to 5%) from carbides of Zr and Hf by the addition of Ni in quantities from 1.5 to 2 wt % and sintering in vacuum at 2100 to 2200°C was investigated. The activation energies for the compression process during sintering of the Zr and Hf carbides with Ni additions in vacuum were calculated as 21.5 and 18.8 kcal/mol, respectively. The very low value of the activation energy of the contraction during sintering of these carbides without activating additions or with additions during sintering in H_2 or during hot compression was indicated. An explanation was given for the observed activation of the sintering process because of the effect of the addition of Ni and the pattern of the process in vacuum, which promotes the elimination of oxide and nitride films, adsorbing gases, and improves the wettability of the nickel carbide. (tr-auth)

15241 THE USE OF CARBON MONOXIDE IN LOW-TEMPERATURE SINTERING OF HIGH-DENSITY UO_2 PELLETS. Miyazaki, Kazuhide (Central Research Labs., Tokyo). Bull. Chem. Soc. Jap., 41: 225-9(Jan. 1968).

The fundamental effects of carbon monoxide on UO_2-pellet densification are described. A high density of more than 95% of the theoretical level was attained using carbon monoxide as the sintering atmosphere at a low sintering temperature of 1400°C for laboratory-processed UO_2 powders. An approximate prediction of the density for any given UO_2 powder may be made from the following two experimental criteria: (a) The experimental activation energy for the rate of dissolution of the material into nitric acid may be taken as a measure for the low-temperature sinterability. The density of sintered oxides rises to a maximum at a point where the value of the activation energy for dissolution is about 20 kcal/mol, which is actually very close to the value for the diffusion of oxygen in uranium oxides. (b) The relative intensity of the (220) peak of the x-ray diffraction pattern furnishes another foundation for judging the densification behavior of the UO_2 sample. (auth)

15242 THE WELDING OF GRAPHITIC CARBON SUBSTANCES. Kareta, N. L.; Nefedov, N. N. Automat. Weld. (USSR) (Engl. Transl.), 20: 61-4(Jan. 1967).

Graphite plates were electroarc butt welded using a consumable electrode. The plates, 10 mm thick, were welded without edge separation with a gap of about 1 mm. The direct current straight polarity arc was excited between the welded plates and the 15-mm dia electrode. Welding conditions included welding current of 200 amp, voltage of 60 V, welding rate of 1.5 m/hr, linear rate of 3 m/hr and a pressure of 120 to 180 atm. A penetration of 6 to 7 mm was obtained. Microstructural analysis indicated that graphite of the weld had a sharply defined columnar structure. A series of experiments was made in diffusion welding grade 30 PG, 50 PG graphite, and anodic and electrode EGO. Specimens were 10 mm in dia. They were heated to 1500 to 4000°C by passing current through them. Compressive force was 1 kg/mm^2. Diffusion seizing appeared at temperatures no lower than 3500°C. The strength of the diffusion welded specimens was very low. Further tests were made in diffusion welding of graphite using an intermediate layer of carbide-forming metal. Titanium, Zr, Nb, Ta, and Hf were tested, forming a refractory eutectic during interaction with carbon. Specimens were heated to 2300 to 3000°C in an inert gas with a current density of 7 to 14 amp/mm^2. Compressive force up to 1 kg/mm^2 was applied. Joint strength depended upon depth of penetration of metal into carbon. The graphite joints made by diffusion welding using a Zr backing were equal to the base metal under short-term loads and temperatures to 2500°C. (Rev.Metal Lit.)

15243 METHOD FOR PRODUCING A CERAMIC FUEL ELEMENT. Hirose, Yasuo (to Hitachi Ltd.). Japanese Patent 1966-18798. Oct. 29, 1966. Filed Oct. 28, 1963.

An improved method is proposed for densely packing ceramic fuel powder into a metal cladding tube by vibration. The advantages obtainable include the increase in thermal efficiency, economy in fuel material, and prevention of the rise in internal pressure during the packing. Ceramic fuel powder is placed in the metal cladding tube, and vibration (or shock) is applied to the tube for packing densely heating to a temperature not exceeding 300°C and under the reduced pressure within the tube. (NSA of Japan)

15244 IMPROVEMENTS IN THE PRODUCTION OF GRAPHITE. Bradwell, Kenneth Vaughan; Harvey, John Terence (to British Acheson Electrodes Ltd.). British Patent 1,098,882. Jan. 10, 1968. Filed Feb. 12, 1964.

A method for preparing a graphite having a high coefficient of thermal expansion consists of preparing a green stock by hot

mixing a crushed carbonaceous binder, extruding the green stock mixture into a shaped product, and then subjecting the shaped product to carbonization and graphitization to produce a graphite. The uncalcined coke used to prepare the carbonizable shaped stock has a degree of fineness such as to provide in the graphite a with-the-grain coefficient of thermal expansion greater than 3.0×10^{-6}/°C from 20 to 100°C. (B.L.M.)

15245 METHOD OF PREVENTING SEGREGATION DURING CASTING OF COMPOSITES. Riley, Robert E.; Sheinberg, Haskell (to United States Atomic Energy Commission). U. S. Patent 3,367,398. Feb. 6, 1968.

A method of preparing a copper-boron carbide composite for casting is described in which the boron carbide powder is coated with tungsten. The tungsten-coated boron carbide powder is mixed with copper powder, and blended. This method prevents segregation during casting. (AEC)

15246 IMPROVEMENTS IN OR RELATING TO A METHOD OF COATING NUCLEAR FUEL PARTICLES. Gough, John Richard Cox; Batchelor, Eric Richard; Kern, Dieter (to United Kingdom Atomic Energy Authority). British Patent 1,100,311. Jan. 24, 1968. Filed Apr. 22, 1964.

A method for coating nuclear fuel particles by pyrolysis of a process gas containing the coating material in a fluidized bed is described. The particles to be coated form the fluidized bed. The bed is levitated and agitated by passing the process gas through the bed from a nozzle at the base of the bed and simultaneously raising the temperature of the bed to a reaction temperature. (F.S.)

15247 HIGH DENSITY CERAMIC BERYLLIA-NUCLEAR FUEL COMPACT CONTAINING AN ADDITIVE FOR THE RETENTION OF FISSION PRODUCTS. Meyer, Robert A.; Lofftus, Fred H. (to United States Atomic Energy Commission). U. S. Patent 3,366,576. Jan. 30, 1968.

A ceramic compact with improved fission product retention consisting essentially of beryllia, certain selected oxide or carbide additives, and fissile or fertile fuel is described. (AEC)

15248 METAL CARBIDE FORMATION ON CARBON FIBERS. Gutzeit, Carlos L. (to Hitco Corp.). U. S. Patent 3,356,525. Nov. 18, 1963.

A method of improving the oxidation resistance of amorphous carbon fibers comprises covering the surfaces of the fibers with and bonding to a layer of heat decomposable organic material containing carbon and metal selected from the group consisting of zirconium, chromium, nickel, titanium or mixtures thereof. Carbon fibers are heat shrunk at about 1800 to 2200°F, and covering materials are decomposed under non-oxidizing conditions at elevated temperatures to carbide while preserving the carbon of the fiber. The temperature is below that at which graphitization occurs. The fibers have improved oxidation resistance at temperatures in excess of 800°F. (Offic. Gaz.)

15249 PREPARATION OF NONPYROPHORIC PLUTONIUM NITRIDE. (to United States Atomic Energy Commission). British Patent 1,101,230. Jan. 31, 1968. Priority date Jan. 13, 1965, United States.

A process that produces a nonpyrophoric plutonium nitride when it is exposed to an air atmosphere is described. Plutonium or PuH_4 powder is heated in a nitrogen atmosphere in a closed vessel to a temperature of about 800°C. The powder is held at this temperature until all gaseous products are removed through a vacuum system. The outgassed powder is then reacted with additional nitrogen gas at this temperature. (M.C.G.)

Properties Evaluations

15250 (GAMD-8374) FRICTION AND WEAR IN PSC CARBON AND GRAPHITE CORE SUPPORT MATERIALS. Stansfield, O. M. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 7, 1967. Contract AT(04-3)-633. 37p. Dep. CFSTI.

The commercial graphite friction couples PGX vs PGX, MHLM vs MHLM, ATJ vs ATJ, and H359 vs H205 were rubbed with oscillating motion 2500- or 5000-inches in dry helium (~2 ppM H_2O) at room temperature (R.T.), 400 and 800°C. Loads of 17.7 pounds were used to produce nominal contact pressures of 250 to 500 psi. The PGX and MHLM couples were also rubbed under a 4.3 pounds load (60 to 120 psi). A baked carbon (B205), and MoS_2 impregnated graphite (TS835) were rubbed on A-537 Grade B steel 250-inches in dry helium at R.T., 100 and 200°C under a 35.3 pounds load (500 psi contact pressure). Friction and wear were correlated with rubbing distance, temperature, load, pre-treatment of PGX surfaces, and surface roughness of the A-537 Grade B steel. The dynamic friction coefficient of TS835 and B205 carbon varied over a wide range with sliding distance and temperature (0.1 to 0.7). At 200°C TS835 had a lower friction coefficient than B205 (0.1–0.4 vs 0.5–0.7). No significant difference in wear rate could be detected between the two materials on steel surfaces of similar roughness. The graphite on graphite couples showed similar friction and wear properties. There apparently was a wearing-in process which caused the friction of graphite outgassed at 400°C first to increase and then decrease during initial sliding (10 to 100 inches). After the initial fluctuation friction was relatively constant. Friction and wear decreased with increasing temperature. The dominant friction coefficient was approximately 0.4, at R.T. and 0.3 at 800°C. Essentially all the wear of PGX (and probably the other graphites) took place within the first 250-inches of sliding. This initial high wear rate was probably associated with a wearing-in process which established an equilibrium surface resistant to wear. Pre-treatment of PGX graphite by rubbing 250-inches at R.T. in air and 400°C in helium did not improve the wear properties at 400°C in helium. (auth)

15251 (IN-1013) RUTHENIUM DIOXIDE–OXYGEN–RUTHENIUM TETROXIDE EQUILIBRIUM. Penman, B. D.; Hammer, R. R. (Idaho Nuclear Corp., Idaho Falls). Jan. 1968. Contract AT(10-1)-1230. 7p. Dep. CFSTI.

The partial pressure of ruthenium tetroxide over ruthenium dioxide as a function of oxygen partial pressure was measured at 453 to 723°C, extending earlier data at higher temperatures. Best current values for $\Delta H^\circ_{f,298}$, $\Delta F^\circ_{f,298}$, and C_p for the oxides of ruthenium are given. (auth)

15252 (SC-RR-67-2947) SOME DYNAMIC MECHANICAL PROPERTIES OF PYROLYTIC BORON NITRIDE. Lee, Larry M. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

Data are presented for the response of 2.18 gm/cc pyrolytic boron nitride (PBN) to impacts producing up to 24 kbar pressure. A linear, rate insensitive, relation between the stress-wave velocity and the particle velocity is observed in this range. The functional dependence is $U_s = 2.56 + 3.84\ u_p$ mm/μsec. Uniaxial stress compression and tension test data are also presented. The compression tests were for strain rates up to 10^3 in./in./sec and the tension tests were to rates of 5 in./in./sec. (auth)

15253 (TID-24210) THE CHARGE ON INTERSTITIAL IONS IN GROUPS IV-A AND V-A TRANSITION METALS. Final Report. Collings, E. W. (Battelle Memorial Inst., Columbus, Ohio). May 22, 1967. 99p. Dep. CFSTI.

It was proposed to measure the charge on interstitial ions in Groups IV-A and V-A transition metals, by measuring the interstitial diffusion when a heavy current is passed through the specimen. During current flow there is an interstitial mass transfer due to electric field migration between the anode and cathode. This results in a composition imbalance in an initially homogeneously charged sample, which is then analyzed to yield the rate of migration. The system of principal interest contains niobium–oxygen. Measurable migration was detected enabling the existence of interstitial oxygen as a positive ion to be determined, although quantitative results could not be obtained. A high-vacuum cell was used with a vac-ion pump to obtain much lower residual gas pressures. It is concluded that interstitial oxygen exists in niobium as a positive ion, and migration under the influence of an applied voltage is toward the cathode. Niobium has a positive Hall coefficient, so that evidence for migration of the interstitials under the influence of the hole flux (as distinct from the electrostatic field) was sought. No conclusive evidence for the operation of a hole flux was obtained. The Soret effect is of the same order of magnitude as the electromigration effect and the experiments show a negative heat of transport for oxygen in niobium resulting in an accumulation of interstitial atoms at the hot zone in the middle of the self-heated strip. Diffusion down the concentration gradient also exists and is therefore in competition with the Soret effect. (J.R.D.)

15254 (ANL-Trans-560) KINETICS OF DISSOLUTION OF Al_2O_3, MgO AND SiO_2 IN CRYOLITE. Shurygin, P. M.; Barmin, L. N.; Boronenkov, V. N. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., 5: No. 4, 106-12(1962). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The dissolution rates of Al_2O_3, SiO_2 and MgO in molten cryolite were measured by the method of revolving samples. It was found that the kinetics of the process is limited by diffusion. Admixtures of NaCl and Al_2O_3 to cryolite inhibit the dissolution of Al_2O_3. In a melt which contains 50 wt. % NaCl, the dissolution process is limited by the diffusion of oxygen ions. The diffusion coefficients are of the order of 10^{-5} cm^2/sec and change regularly with the composition of the solution. The activation energy of the dissolution process in the above mentioned melt is equal to 40,000 cal/

mole and the activation energy of diffusion is 13,700 cal/mole. (auth)

15255 LATTICE AND GRAIN-BOUNDARY DIFFUSIONS OF PROTACTINIUM IN ThO_2 AND IN A ThO_2–UO_2 SOLID SOLUTION. Furuya, H.; Yajima, S. (Tohoku Univ., Sendai). J. Nucl. Mater., 25: 38-44(1968).

Lattice and grain-boundary diffusions of protactinium ions in sintered ThO_2 and ThO_2–UO_2 solid solution with an atomic ratio of 1:1 were measured at 1800 to 2000°C, by using ^{233}Pa as a tracer and by the sectioning method. The data obtained were analyzed in the light of the theory concerning grain-boundary diffusion based on a constant source model. The lattice diffusion coefficients D can be obtained by: D (Pa in ThO_2) = $2.91 \times 10^{-5} \times \exp(-75{,}400/RT)$ cm^2/sec and D (Pa in ThO_2–UO_2) = $188 \times 10^{-3} \times \exp(-91{,}800/RT)$ cm^2/sec. The products $D \cdot 2a$, peculiar to grain-boundary diffusion are: $D' \cdot 2a$(Pa in ThO_2) = $6.66 \times 10^{-11} \times \exp(-30{,}600/RT)$ cm^3/sec and $D' \cdot 2a$(Pa in ThO_2–UO_2) = $5.64 \times 10^{-8} \times \exp(-59{,}700/RT)$ cm^3/sec, where D' and 2a are the grain-boundary diffusion coefficient and the grain-boundary width, respectively. (auth)

15256 HEAT CONTENT OF URANIUM DIOXIDE FROM 1200 TO 3100°K. Hein, R. A.; Sjodahl, L. H.; Szwarc, R. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater., 25: 101-4(1968).

Enthalpy measurements were made on UO_2 from 2620 to 3100°K by means of the drop technique. The specimens were prepared from 99.9+% pure UO_2 powder that was cold pressed into pellets and sintered. The enthalpies of sapphire and tungsten were determined as a function of temperature from 1200 to 2170 and 3250°K, respectively. (M.C.G.)

15257 HOT-PRESS CERAMICS FOR HIGH STRENGTH AND PRECISION. Miccioli, Bruno R.; Wise, Douglas C. Mater. Eng., 66: 76-8(July 1967).

Examples of hot pressed ceramics with precise dimensional tolerances and very high strength are shown. Included are a nozzle which is a composite of carbide and graphite layers, a four-layer rocket nozzle which consists of an inner layer of hafnium carbide and successive outer layers of tantalum carbide with increasing graphite content, and a niobium carbide ceramic part reinforced with continuous graphite yarn for added strength. Process variables affecting the properties (density, average grain diameter) of hot formed ceramic parts include pressure, temperature, hold time and material composition. Other applications for hot pressed ceramic parts are: aluminum oxide cutting tools, extrusion dies and high-quality dielectric components; boron carbide sandblasting nozzles, crush rollers and mold liners for making grinding wheels. Boron nitride slugs are being machined into many parts, including resistance heating elements, electrical insulators and heating coil forms. (Rev. Metal Lit.)

Structure and Phase Studies

Refer also to abstracts 15151 and 15234.

15258 SOLUBILITY OF URANIUM IN URANIA. Fryxell, R. E.; Joyce, D. E.; Szwarc, R. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Nucl. Mater., 25: 99-100(1968).

In studies of the electric conductivity of UO_2 at high temperatures, two discontinuities appeared in the temperature dependency for substoichiometric compositions. The temperatures at which these discontinuities appeared were a function of the degree of oxygen deficiency in the specimen. (M.C.G.)

15259 PHASE RELATIONSHIPS IN THE AMERICIUM–OXYGEN SYSTEM. Chikalla, T. D. (Battelle Memorial Inst., Richland, Wash.); Eyring, L. J. Inorg. Nucl. Chem., 30: 133-45(Jan. 1968).

Phase relations in the americium–oxygen system between 1.50 O/Am < 2.00 were studied using Guinier and Debye diffraction methods on quenched and annealed samples. The cubic Am_2O_3 phase was capable of dissolving excess oxygen and of existing at room temperature, over a wide range of stoichiometry. The upper boundary of this phase occurs at about $AmO_{1.67}$. Between this composition and $AmO_{1.90}$ at least one other intermediate phase is thought to exist. Evidence was found for what is believed to be a new Am_2O_3 phase, which is probably monoclinic (B-type rare earth sesquioxide structure). The likelihood for the existence of this phase, as well as the cubic and hexagonal Am_2O_3 phases, is discussed in terms of a lanthanide/actinide oxide analogy based on considerations of ionic radii. A homologous series of substoichiometric ordered intermediate phases was not observed. The lack of such phases in this system is thought to be influenced by self-induced radiation damage caused by the alpha decay of americium-241. (auth) (UK)

Radiation Effects

Refer also to abstract 15259.

15260 (AERE-M-1612) UNIT CELL SIZE OF SOLID SOLUTIONS OF URANIUM DIOXIDE AND FISSION PRODUCT OXIDES. McIver, E. J. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1966. 5p. Dep. CFSTI. UK.

The effects of fission products on the cell dimension of UO_2 were studied, and are compared with the values calculated from ionic radii. (auth) (UK)

15261 (BMI-1819) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY THROUGH SEPTEMBER 1967. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1967. Contract W-7405-eng-92. 51p. Dep. CFSTI.

Progress is reported on UN–PUN fuels for LMFBR applications, radiation effects on materials for fast reactors, properties of ceramic-coated Pu-base fuels, and properties of ceramic-coated U-base fuels. (J.R.D.)

15262 (N-66-37213) MATERIALS DEVELOPMENT FOR SOLAR CELL APPLICATIONS. Final Report, June 1, 1965–May 31, 1966. Topfer, A. R. (Radio Corp. of America, Mountaintop, Pa. Industrial Tube and Semiconductor Div.). June 25, 1966. 78p. (NASA-CR-78132). CFSTI.

Silicon containing lithium as an impurity to interact with radiation damage centers was investigated. Solar cells having the n-on-p as well as p-on-n structures were prepared and radiation tested. Prototype p-on-n cells having lithium in concentrations of 5×10^{17} atoms/cc in the n-range have shown improved resistance to high energy electron bombardment. At a dosage of 10^{15} 1 MeV electrons/cm^2 as high as 93% of the pre-irradiated short-circuit current was retained. A second material investigated was aluminum antimonide. The zinc and cadmium diffused p-on-n structure investigated resulted in cells having efficiencies limited to about 1%, air mass one. It was concluded that suitably formed junctions less than 1 micron deep would be required for high conversion efficiencies. However, this was too shallow to be achieved with sufficiently high doping concentrations using either zinc or cadmium. Various mathematical representations of the processing and irradiation effects permitted defining the range of processing variables necessary to give required characteristics and predicted post-irradiation performance of the cells. (STAR)

15263 RADIATION EFFECTS IN CERAMIC FUELS. Bradbury, B. T.; Frost, B. R. T. (Atomic Energy Research Establishment, Harwell, Eng.). pp 159-297 of Studies in Radiation Effects on Solids. Vol. II. Dienes, G. J. (ed.). New York, Gordon and Breach Science Publishers, 1967.

Radiation damage processes are discussed. Electron microscopy has been applied for studying fission tracts and point defects and loops. Physical property measurements on UO_2, carbides, and nitrides are presented. The production and behavior of gaseous and solid fission products in ceramic fuels are discussed. The fission products and swelling behavior of oxides and carbides are summarized. (J.C.W.)

15264 RADIATION EFFECTS IN SEMICONDUCTING GLASSES. Hench, L. L.; Daughenbaugh, G. A. (Univ. of Florida, Gainesville). J. Nucl. Mater., 25: 58-63(1968).

The electric conductivities of semiconducting glasses in the V_2O_5–P_4O_{10} system are relatively insensitive to γ doses of 1.25×10^8 rad and integrated fluxes of 4×10^{17} nvt. A 10% increase in conductivity was observed after the γ exposure. The location of the high-frequency critical temperature, and the activation energies of high-frequency and low-frequency conduction are unchanged with the irradiation levels of this study. (auth)

15265 CHANGES IN THE STRUCTURE OF GRAPHITE ON IRRADIATION UNDER RESTRAINT. Richards, B. P.; Kellett, E. A. (General Electric Co., Ltd., Wembley, Eng.). J. Nucl. Mater., 25: 45-57(1968).

As part of a program of work designed to investigate the behavior on irradiation by fast neutrons of various types of graphite that are restrained from growing, x-ray diffraction measurements were made in an attempt to follow changes in the crystalline character of the graphite at various stages of the "restrained growth" experiment. The experimental methods used and the appropriate correction procedures are discussed. It is shown that, on neutron-irradiation, the application of a growth-restraining mechanism considerably reduces the rate at which crystal damage takes place. For the most heavily irradiated samples this

retardation of the crystal damage is very marked indeed. Quantitative measurements of the changes in interlayer spacings of the irradiated specimens from the value for the original material are consistent with this conclusion. Recovery of the original interlayer spacing was effected for all specimens by annealing at 2400°C. By contrast, full recovery of the crystal structure order did not appear to have taken place. The results are compared with other published data and their interpretation is discussed in terms of current ideas of crystal damage induced by neutron irradiation. (auth)

15266 IRRADIATION DAMAGE AND IRRADIATION HARDENING IN SINGLE CRYSTAL MgO AFTER LOW NEUTRON DOSES <10^{18} NVT (>1 MeV). Davidge, R. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 25: 75-86(1968).

MgO crystals containing <5000 ppM Fe were heat treated in various ways, to control the form of the iron (Fe^{2+} or Fe^{3+}), and then irradiated to doses (ϕ) <10^{18} nvt (>1 MeV). The critical resolved shear stress (CRSS), the optical absorption spectrum, and the lattice parameter were measured as a function of dose and of post-irradiation annealing. The increase in CRSS varies as $A\phi^{\frac{1}{2}}$, where A is a constant. A is greatest when iron in Fe^{2+} form is present, and increases with increasing iron content. The hardening is more resistant to annealing when Fe^{2+} is present. No simple correlations exist between the hardening and either the concentrations of color centers or the lattice parameter changes. A speculative model is presented for the observed behavior. (auth)

Plastics and Other Materials

Refer also to abstracts 14619 and 14716.

15267 (BMI-X-10220) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, October–December 1967. Lankard, D. R.; Fondriest, F. F.; Snyder, M. J. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1968. Contract W-7405-eng-92. 26p. (EURAEC-1969). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Unrestrained 4 by 8-in. cylindrical and 2 by 2-in. cube sections of gravel and limestone concretes were exposed to temperatures of 175, 250, 375, and 500°F for extended periods of time (up to $3\frac{1}{2}$ mo). It was found that concrete exposed to temperatures up to 500°F increase in compressive strength if chemical and thermal equilibria are attained and a minimum of differential movement occurs in the specimen during heating and before testing. Diminutions in compressive strength will be observed if an excess of evaporable water is present relative to the equilibrium value, differential movements are created or the moisture is contained in the specimen during heating. Concrete exposed to temperatures above 500°F experience a deterioration in compressive strength. Concretes heated above ambient temperature, always experience a deterioration in the modulus of elasticity. At temperatures up to 500°F the condition of the cementiceous calcium silicate hydrates (and the other hydrate phases) does not play a significant role in changes observed in the structural properties. A correlation exists between the response of concrete structural properties of heated concretes. Mechanisms responsible for the observed changes in the structural properties of heated concrete may be quite different depending on whether the free water is contained or allowed to evaporate. Increased number of thermal cycles or rapid quenching cause the most serious deterioration of structural properties. (F.S.)

15268 (ORO-2945-9) FASTENING OF WOOD–PLASTIC COMBINATIONS. Topical Report. Loos, Wesley E.; Kent, James A. (West Virginia Univ., Morgantown. Engineering Experiment Station). Sept. 1, 1967. Contract AT(40-1)-2945. 39p. Dep. CFSTI.

The fastening of wood-plastic combinations (WPC), by both adhesives and mechanical fasteners was studied. Wood-plastic combinations can be satisfactorily glued before or after treatment. The gluability of several radiation produced wood-plastic combinations was tested with four commercially available adhesives. Resorcinol based adhesives gave the best results of the glues tested. Polyvinyl acetate (PVC), urea-formaldehyde (U–F) and casein adhesives formed satisfactory glue bonds with WPC as long as the polymer loading of the WPC was not too high. By using WPC with a lower moisture content the glue bonds formed by PVC and U–F adhesives were much better than those produced by WPC with a high M.C. These results indicate that if U–F or PVA adhesives were formulated with a moisture diffusion rate to match that of the WPC, the glue bonds obtained would probably be improved. Mechanical fasteners such as conventional wood screws and threaded fasteners perform satisfactorily in fastening WPC. Fastening WPC with nails is not advised. Three threaded inserts plus a standard tapped hole and bolt were evaluated. All of these thread-type inserts gave high performance in fastening WPC. (auth)

15269 EFFECT OF EXPLOSION ON MATERIALS. NEW MODIFICATION OF URANIUM TETRAFLUORIDE. Deribas, A. A.; Ruchkin, E. D.; Filatkina, V. S.; Khripin, L. A. Fiz. Goreniya Vzryva, No. 4, 143-6(1966). (In Russian).

The effect of impact compression on $\alpha-UF_4$ was investigated. The compression was carried out in steel cylinders, and the explosive used was hexogen. The pressures and temperatures achieved during compression were 160 to 500 kbar and 400 to 1600°C respectively. The density, refractive index, dielectric constant, IR spectrum, x-ray spectrum and DTA spectrum of the compressed specimens were determined. It was concluded that $\alpha-UF_4$ is converted to $\gamma-UF_4$ as a result of the high pressures and temperatures created during the explosion. (ATD)

15270 DEGRADATION OF PLASTICS IN THE PILE IRRADIATION. Sugisaki, Yoshiyuki (Showa Electric Wire and Cable Co., Ltd., Japan); Nagao, Hiroyuki. Showa Densen Denran Rebyu, 17: 86-96(July 1967). (In Japanese).

The safety standards for radioresistant plastics which are used as materials for pile irradiated vessels are shown. Seven types of plastics were selected as testing materials including high density polyethylene, low density polyethylene, polystyrene, and polycarbonate. Their mechanical, chemical, and electrical properties, are discussed. β-naphthoquinone, di-β-naphthyl-P-phenylenediamine are added to antirads of polyethylene. (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 14831, 15385, 15444, and 15504.

15271 (NEIC-RR-28) RELATIVISTIC SPHERES AS MODELS OF NEUTRON STARS. Kuchowicz, B. (Nuclear Energy Information Center, Warsaw (Poland)). 1967. 26p. Dep.

In relativistic astrophysics one deals with the set of equations for the gravitational field, pressure, and density. Usually these equations are solved with the help of computers. If solutions expressed in terms of known functions are obtained, such exact solutions are of some use as models of superdense configurations. Two tables are presented here of some recently derived solutions of such type. (auth)

15272 FORMATION OF Li, Be, AND B IN THE EXPANDING HOT UNIVERSE. Sato, Humitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 1083-94(Nov. 1967).

The hot Universe model suggests the element formation by thermonuclear fusion at the early stage of cosmic expansion. The primordial origin of Li, Be, and B is examined. The abundances of all the stable isotopes of Li, Be, and B produced are estimated. In the case of Friedmann models with the present matter density $\rho_{0m} = 10^{-32} \sim 10^{-29}$ g/cm^3 and the present radiation temperature $T_0 \simeq 3°K$, the produced quantities are $D < 10^{-2.0}$, $^3He < 10^{-3.5}$, $^4He < 10^{-1.0}$, $^6Li < 10^{-12.7}$, $^7Li < 10^{-9.5}$, $^9Be < 10^{-13.3}$, $^{10}B < 10^{-16.7}$ and $^{11}B < 10^{-13.0}$, by the ratio to hydrogen in number density. Therefore, the observed abundances of Li, Be, and B cannot be explained by the primordial origin. (auth)

15273 LITHIUM CONTENT OF T TAURI-TYPE STARS AND OF COSMIC RADIATION. Gurzadyan, G. A. (Burakan Observatory, Erevan). Dokl. Akad. Nauk SSSR, 176: 291-4 (Sept. 11, 1967). (In Russian).

In more than 20 T Tauri-type stars the lithium/metal ratio was found to be higher than in the Sun. The presence of lithium in the atmosphere of stars indicates that certain elements may be formed directly by nuclear reactions, therefore it was tried to determine the true lithium atom content of the atmosphere of these stars. This requires a study of the ionization of lithium on the conditions prevailing in the stars. In the absence of direct observations it was assumed that the ionizing nonthermal radiation is due to the inverse Compton effect, proposing a steady-state condition between the photoionization processes from the ground state of neutral lithium and the recombination processes of ionized lithium atoms with free electrons. The calculations showed that the total amount of lithium atoms in the atmosphere of the T Tauri-type stars must be at least 1×10^4 times higher than on the Sun. This finding is of interest in view of the anomolously high light-element content of cosmic radiation. Attempts to verify these theories on the basis of isotopic analysis of the lithium content in cosmic rays were unsuccessful. (TTT)

15274 ISOPHOTE CHARTS OF THE CORONAL LINES λ 5,303 AND λ 6,374 A. Rozelot, Jean-Pierre (Observatoire du Pic du Midi, Hautes-Pyrenees, France). Compt. Rend., Ser. A and B, 265: 1267-9(Nov. 27, 1967). (In French).

The photographic method used at the observatory of the Pic du Midi to observe the solar corona using achromatic coronography previously described (Compt. Rend., 261: 4269(1963)) was used in this study. Pictures were obtained of the coronal lines λ 5,303 and λ 6,374 Å, especially the latter, for all angles of position and in a short time interval. (tr-auth)

15275 THE SOLAR WIND. PART I. Kubiak, Marcin. Postepy Astron., 15: 273-84(1967). (In Polish).

The solar corpuscular radiation consists of quasi-static jet of ionized gas with an average speed of about 500 km/sec, related to the active regions of the Sun; and an ionized gas jet with an average speed of about 1500 km/sec, characterized by changing speed and density. The "solar wind" refers to the corpuscular radiation with speed of about 500 km/sec and a temperature of the order of 10^{5}°K. The first results concerning the composition of interplanetary matter are tabulated; they include data on the intensity of the magnetic field and ion streams. The following conclusions may be drawn from the exploratory space flights of Mariner-2, Explorer 18, and other satellites: the average speed of protons is about 505 km/sec, with a jet density varying from 0.2 to 70 protons/cm^3; the product of density and speed decreases with the distance from the Sun, following approximately the $1/r^2$ rule; at great distances from the Earth, there is a constant magnetic field about 2×10^{-5} to 3×10^{-5} gauss. The absolute intensity of the interplanetary magnetic field is $\sim 4 \times 10^{-5}$ gauss; it changes with a period equal to the period of the Sun's rotation. The Crab Nebula was used as a radio source for studying the composition of interplanetary matter. (TTT)

15276 LUMINOSITY FUNCTION OF GALAXIES. Zonn, W. Postepy Astron., 15: 299-305(1967). (In Polish).

The significance of the luminosity function in the solution of problems of extragalactic astronomy is illustrated by calculations. The absolute luminance of the galaxy may be evaluated from the red shift and the observed luminance, as indicated by the works of T. Kiang. His investigations show that the probability of the presence within the observed galaxies of an object with an absolute luminance greater than $x = m + 22 = 8.0$, (or greater than -14^m), is less than 0.001. Further investigation is needed to determine whether the luminosity function can be extended to objects weaker than -14^m. Similar results were obtained by Neyman and Scott and Holmberg. Another method of investigation was adopted by Zwicky whose result is different from those reported by the other investigators. (TTT)

15277 AN ATTEMPT OF IDENTIFICATION OF THE ^{25}MgH AND ^{26}MgH BANDS IN STELLAR SPECTRA. Kubiak, M.; Smak, J. Postepy Astron., 15: 315-16(1967). (In Polish).

An attempt was made to identify the isotopes of magnesium in the atmosphere of stars by analyzing the absorption bands of MgH. The study involved a determination of the expected shift of the ^{25}MgH and ^{26}MgH lines with respect to those of ^{24}MgH using the strongest bands (0,0) with λ = 5211 and (1,0) with λ = 4845. The tabulated data originally indicated an easy identification of the lines belonging to the bands of ^{25}MgH and ^{26}MgH but analysis of the spectrograms with a resolution of 8 Å/mm on which the study was carried out revealed that the bands were not sufficiently strong for definite identification. Band (1,0) falls into a region, in which strong lines of metal and TiO predominate, making it necessary to limit further analysis to the band (0,0). All the MgH lines from 4950 to 5150 Å and the absorption lines of the metals and of TiO were identified. At least a few of the ^{25}MgH and ^{26}MgH lines fall in a relatively clear region; they may be identified by using an instrument with a resolution of at least 2 Å/mm. (TTT)

15278 APSIDAL ROTATION IN THE ECLIPSING SYSTEM XZ ANDROMEDAE. Todoran, I. (Univ., Cluj). Bull. Astron. Inst. Czech., 18: 328-30(1967). (In German).

A comparison of the O−C diagrams and the site of the secondary radiation in the Blitzstein light curve confirms the hypothesis that the periodic oscillation can be caused by an apsidal rotation. It is proposed that a series of new photoelectric observations in the years 1967−1969 can give data on the validity of the Blitzstein hypothesis with respect to the duration of the two minima of the eclipsing system XZ Andromeda. (tr-auth)

15279 SOME PROBLEMS CONCERNING MECHANISMS OF SOLAR FLARES AND ENERGY ACCUMULATION. Guseinov, R. E. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, Nos. 3-4, 57-63(1967). (In Russian).

An attempt is made to prove quantitatively that solar flares are shock waves which result from point explosions in the solar atmosphere. The data obtained on the mechanisms producing such flares and on the formation energy in the flares are discussed, considering the theory of gasomagnetic turbulence with supersonic velocities and collective plasma processes. 32 references. (R.V.J.)

15280 RECENT ADVANCES IN THE STUDY OF VARIABLE STARS. Buscombe, William (Australian National Univ., Canberra). Aust. J. Sci., 30: 203-7(Dec. 1967).

Particular reference is made to classical cepheids and long-period red-giant variables within the general class of periodically pulsating stars, and to flare stars, novae, and supernovae which have more erratic and cataclysmic outbursts. (W.D.M.)

15281 A TWO-CELL PHOTOELECTRIC POLARIMETER AT THE UPPSALA OBSERVATORY USED FOR OBSERVATIONS OF SOME MAGNETIC VARIABLES AND OTHER STARS. Elvius, Aina; Engberg, Mona (Uppsala Univ.). Ark. Astron., 4: 387-403(1967).

A photoelectric polarimeter for accurate measurements was constructed at the Uppsala Observatory. A description is given of the instrument and method of observation as well as the accuracy obtained in the observations. The possible polarization of some bright stars, known to be magnetic variables, were investigated. A report on these observations is given. (auth)

15282 STUDY OF POSSIBLE VARIATIONS IN THE POLARIZATION OF STARLIGHT. Loden, Lars Olof. Ark. Astron., 4: 357-73(1967).

Fourteen stars with various degrees of light polarization were subjected to repeated polarimetric observations in various color regions. The results indicate a certain irregular time variation of the polarization which might possibly be connected with terrestrial phenomena (atmospheric, instrumental, or both). A statistical correlation that was found between polarization degree and wavelength agreed qualitatively with that found in earlier investigations. (auth)

15283 PHOTOMETRIC STANDARD SEQUENCES IN THE CRUX REGIONS (WITH SHORT DISCUSSION OF THE ABSORPTION CONDITIONS IN THE REGIONS). Loden, Lars Olof (Stockholm Observatory). Ark. Astron., 4: 375-86(1967).

Photoelectric UBV photometry was performed at the Boyden Observatory of 250 stars in the Crux regions (including also a part of Centaurus) in order to give a useful standard connection sequence for continued photoelectric or photographic photometry in the regions. An attempt was also made to study the general behavior of the interstellar absorption in the actual part of the Milky Way which inter alia contains the Southern Coal Sack. It has not been possible to obtain a reliable value of R for any of the regions. (auth)

15284 DETECTION PRINCIPLE FOR PHOTOELECTRIC POLARIZATION MEASUREMENTS ON FAINT STELLAR OBJECTS. Wiedling, T. Ark. Astron., 4: 349-56(1967).

Since interstellar polarization effects are comparatively small there are experimental difficulties in measuring star light polarization accurately. Even minor background effects may completely mask the polarization. An electronic technique applicable to polarization measurements is described. Principally, it is a filter with a very small pass band and it is mainly to be used in photon counting on faint objects. The technique is also applicable in multicolor photometry and spectroscopy. (auth)

15285 INVESTIGATIONS OF A MILKY WAY FIELD IN SCORPIUS. IV. A PHOTOELECTRIC SEQUENCE OF A–K STARS. Roslund, Curt (Lund Observatory, Sweden). Ark. Astron., 4: 341-7(1967).

A sequence of twelve stars of spectral types A0 and later and of an apparent brightness V ranging from 10.5 to 13.3 mag. was set up photoelectrically in the UBV system at R. A. 17^h09^m5 and Dec. $-33°12'$ (1950). Thirteen additional stars taken from the Henry Draper and Henry Draper Extension Catalogues were measured in the field surrounding the sequence. A renewed discussion of extinction data for the atmosphere of the Earth, together with new extinction determinations, shows that the origin of the air mass prevailing at the time of observation is the determining factor for the transparency of the sky above the Boyden Observatory. (auth)

15286 OBSERVATIONS OF SUNSPOTS USING SHEARING INTERFERENCE OF THE DIFFRACTION IMAGE. Ohman, Yngve. Ark. Astron., 4: 319-21(1967).

Observations of sunspots are reported when shearing interference of the diffraction image of the telescope is produced. The images show a different shape for different phase differences between the two superimposed images in good agreement with previous calculations. An influence of atmospheric seeing is noticed indicating that the coherence in the diffraction image is somewhat destroyed sometimes by bad seeing. (auth)

15287 SPECTROGRAPHIC OBSERVATIONS OF DARK SURGES AND MOTTLES AT THE SOLAR LIMB. Ohman, Yngve. Ark. Astron., 4: 317-18(1967).

By using the Babcock grating of the Swedish Solar Observatory in Anacapri some observations were made of the chromospheric Hα line at the limb using a tangential slit. In images of good definition nonsymmetrical absorption effects were traced indicating dark surges and mottles. This suggests a method for observing such objects at the limb. A comparison is made also of chromospheric spectra and the spectra of flares. (auth)

15288 THE OPEN CLUSTER NGC 6031. Lindoff, Ulf (Univ. of Lund, Sweden). Ark. Astron., 4: 305-16(1967).

Photographic magnitudes are determined in the UBV system for the open cluster NGC 6031. The magnitude sequence is transferred from NGC 6067. The color excess is 0^m43 and the distance modulus is 12^m5, corresponding to a distance of 3200 pc. The age is estimated at 3×10^7 years. (auth)

15289 RADIAL VELOCITY OBSERVATIONS OF PROMINENCES. Liszka, Ludwik (Kiruna Geophysical Observatory, Sweden). Ark. Astron., 4: 301-3(1967).

During the period Jan.–Feb. 1966 a number of high-dispersion prominence spectra at the Hα line was collected using the 20-m horizontal telescope at Capri. A Babcock grating having 610 lines/mm is used in the instrument. The spectra were observed in the fourth order, giving a linear dispersion on the film of about 1.42 Å/mm at Hα. The slit width used was about 0.33 mm. In all, about 250 spectra of more than 100 prominences were taken. Most of the objects investigated were quiescent ones. (W.D.M.)

15290 BIOLOGIC EFFECTS OF SUPERNOVAE. Terry, K. D. (Univ. of Kansas, Lawrence); Tucker, W. H. Science, 159: 421-3(Jan. 26, 1968).

Estimates of the probability that nearby explosions of supernovae have occurred during the Earth's history and the biologic effects of the radiation therefrom are presented. They suggest that cosmic radiation from supernovae could have caused the extinction of many exposed animals without the simultaneous extinction of plant life. This suggests that supernovae should be considered as one possible mechanism by which fauna become extinct. (auth)

15291 SOLAR X RAYS. Underwood, J. H. (Goddard Space Flight Center, Greenbelt, Md.). Science, 159: 383-90(Jan. 26, 1968).

New observational techniques and refinements of theory for solar x rays are reviewed. Topics discussed include experimental methods, comparison of experimental results with theory (the quiet Sun), emission from active regions, transient x-ray events, and effects of x rays on the ionosphere. 23 references. (W.D.M.)

15292 UPPER LIMITS TO THE HARD X-RAY FLUXES FROM MARS, VENUS, AND JUPITER. Haymes, R. C.; Ellis, D. V.; Fishman, G. J. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 867-70(Feb. 1, 1968).

A balloon experiment was conducted on August 10, 1966, that searched for photons with energies between 30 and 465 keV from Mars, Venus, and Jupiter. No increases above background were observed from any of the planets although the emissions from the Crab Nebula were detected. The quiet-Sun upper limit on the planetary fluxes between 40 and 100 keV was 1.8×10^{-2} photon/cm^2 sec. Mars and Venus are not expected to be x-ray sources because they are neither unusual radio sources nor are they surrounded by trapped radiation. The upper limit on the strength of the Jovian x-ray source of 2×10^{20} ergs/sec was equivalent to 10^{-3} of the solar-wind energy at the Jovian magnetosphere. The quiet-time Jovian source strength to be expected is discussed. (auth)

15293 ACCURATE POSITIONS OF 210 RADIO SOURCES. Shimmins, A. J. (Commonwealth Scientific and Industrial Research Organization, Chippendale, Australia). Aust. J. Phys., 21: 65-79(Feb. 1968).

The right ascensions and declinations of 210 radio sources were determined. For most of the sources the estimated error is less than 16″ arc in each coordinate. The sources were selected from the Parkes catalogue of radio sources and are between declinations +27° and −33°. (auth)

15294 IDENTIFICATION OF RADIO SOURCES BETWEEN DECLINATIONS $+27^0$ AND -30^0. Bolton, J. G.; Shimmins, A. J.; Merkelijn, Jeannette (Commonwealth Scientific and Industrial Research Organization, Chippendale, Australia). Aust. J. Phys., 21: 81-6(Feb. 1968).

Seventy-four identifications were made from inspection of the 48-in. Sky Survey prints in positions of 150 sources measured with the 210-ft telescope. Thirty-seven of the identified sources are galaxies and 37 possible quasi-stellar objects. In 26 cases, previously suggested identifications are confirmed. Finding charts are given for the remainder. (auth)

15295 OBSERVATIONS OF 31 RADIO SOURCES BETWEEN 40 AND 130 MHz. Haynes, R. F.; Hamilton, P. A. (Univ. of Tasmania, Hobart, Australia). Aust. J. Phys., 21: 87-94(Feb. 1968).

Recent observations of 31 radio sources in the frequency range 40 to 130 MHz obtained at the Australian National Radio Astronomy Observatory, Parkes, N.S.W., are reported. The results obtained show that some useful information about source emission mechanisms may be deduced. (auth)

15296 HIGH RESOLUTION OBSERVATIONS OF THE ORION NEBULA AT 408 MHz. Mills, B. Y.; Shaver, P. A. (Univ. of Sydney). Aust. J. Phys., 21: 95-102(Feb. 1968).

The Orion Nebula was observed at 408 MHz with the 1 mile Cross radio telescope at the Molonglo Radio Observatory. NGC 1976 and NGC 1982 were observed separately and the former was well resolved. Comparison with high-frequency results shows

that the central region is optically thick; the electron temperature was measured directly at 7,600 ± 800°K. Both nebulae are strongly concentrated towards their exciting stars. (auth)

15297 ENERGY DISTRIBUTION OF ELECTRONS PRODUCING MICROWAVE IMPULSIVE BURSTS AND X-RAY BURSTS FROM THE SUN. Takakura, Tatsuo; Kai, Keizo (Tokyo Univ.). Astron. Soc. Jap., Publ., 18: 57-76(1966).

The energy distribution of high-energy electrons which emit gyrosynchrotron radiation as microwave impulsive bursts as a function of time, for some plausible initial distribution functions, is computed. The theoretical decay curves of the radio emission from these electrons are compared with observed decay curves of the radio bursts to deduce the initial energy distribution. A comprehensive model of radio and hard x-ray bursts (>20 keV) is proposed. A major part of high-energy electrons is trapped in a region invisible at radio frequencies. This region may be the source of hard x-ray bursts. On the other hand, a small fraction (on the order of $10^{-3} \sim 10^{-4}$) of the high-energy electrons is trapped in an outer region and contributes to the microwave impulsive burst. (IAA)

15298 OBSERVATION OF GALACTIC X RAYS. Hayakawa, Satio; Matsuoka, Masaru; Ogawa, Hideo; Yamashita, Koujun. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 928-39(July 1966). (In Japanese).

The intensity and energy spectra of galactic x-ray sources, Tau X-1, and other celestial bodies were studied, using three Geiger counters sensitive to the 1.5 ~ 3.9, 3.9 ~ 7.5, and 7.5 ~ 11 Å wavelengths, respectively. The preliminary results were as follows: (1) the flux intensities of x rays from the Crab Nebula in the above three wavelength ranges were equal to 0.23 ± 0.13, 1.3 ± 0.8, and 6 ± 3 photons/cm^2/sec/keV, respectively, and (2) those for isotropic x rays in the 1.5 ~ 4 Å wavelength were 5 ± 2 photons/cm^2/sec/sr. (IAA)

15299 GENERATION OF ACOUSTIC AND GRAVITY WAVES BY TURBULENCE IN AN ISOTHERMAL STRATIFIED ATMOSPHERE. Stein, Robert F. (Columbia Univ., New York. Goddard Inst. for Space Studies, New York). Solar Phys., 2: 385-432(Dec. 1967).

Lighthill's method of calculating the aerodynamic emission of sound waves in a homogeneous atmosphere is extended to calculate the acoustic and gravity-wave emission by turbulent motions in a stratified atmosphere. (auth)

15300 MAGNETIC-FIELD ACCUMULATION IN SUPERGRANULES. Clark, Alfred Jr.; Johnson, H. Kevin (Univ. of Rochester, N. Y.). Solar Phys., 2: 433-40(Dec. 1967).

Some theoretical models illustrating the growth of magnetic fields around the boundaries of supergranulation cells are given. The evolution of a magnetic field in a prescribed velocity field is calculated for the idealized case of hexagonal cells. The calculations are carried out both for a perfect conductor and a fluid of finite conductivity. The theory is developed in such a way as to be virtually free of specific assumptions about the depth dependence of the supergranulation flow. The results demonstrate the tendency of the field to accumulate at those boundary points where the flow is most strongly converging. (auth)

15301 THE RELATIVE INTENSITIES OF CI LINES IN THE SOLAR EUV SPECTRUM. Jordan, Carole (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Solar Phys., 2: 441-50(Dec. 1967).

The relative intensity of two C I lines at 1993.6 and 1657.4 Å, observed in the limb spectrum of the Sun, is a factor 2.6×10^3 larger than that expected if both lines were optically thin. It is shown that the observed intensity ratio may be explained in terms of the transfer of photons from λ 1657.4 to λ 1993.6 Å due to a large optical depth in the line at 1657.4 Å. The observed upper limit on the relative intensity of two further lines at 1992.0 and 1657.0 Å has been used to show that the line at 1993.6 Å is optically thin. Hence it is shown that τ(1657.4 Å) = 1300, and τ(1993.6 Å) = 0.44. These values provide an independent evaluation of optical depths against which chromospheric models may be checked. Assuming a mean temperature of T_e = 8000°K, and a mean scale height of 350 km, the optical depths lead to a mean hydrogen-particle density of $N(H) = 1.4 \times 10^{12}$ cm^{-3}. (auth)

15302 ARCH-FILAMENT SYSTEMS IN SPOTGROUPS. Bruzek, A. (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 2: 451-61(Dec. 1967).

Systems of arch-shaped filaments (AFS) occurring in the interspot region of young bipolar groups are studied. Their main characteristics are: average length, 30,000 km; average width, 20,000 km; width of individual filaments, 1000 to 3000 km; height of arches, 4 to 15,000 km. A typical lifetime of the filaments is 30 min; appreciable changes in the system occur within several hours; the lifetime of a system is about three days. The arch-filament systems bridge the "neutral" line and connect the regions of the innermost spots of opposite polarity. Material moves along the filaments (v ~ 25 to 50 km/sec) following the direction of the magnetic field, and sometimes arches are observed rising at a rate of ~20 km/sec. They are very dark on the inner disk and appear either in emission or in absorption close to the solar limb. The occurrence of "bright points" (moustaches) is found to be closely associated with AFS in young spotgroups. The possible nature of AFS and their relation to other types of filamentary structures is discussed. (auth)

15303 SOLAR FLARES AS RESULTING FROM THE TEMPORARY INTERRUPTION OF ENERGY FLOW TO THE CORONA: A CASE OF HYDROMAGNETIC RESONANCE. Pneuman, G. W. (High Altitude Observatory, Boulder, Colo.). Solar Phys., 2: 462-83(Dec. 1967).

The hypothesis that solar flares may be caused by a choking off of the normal energy flux to the corona by the strong closed magnetic fields of a plage is examined. If the energy flux into a plage from the photosphere is of the order of 10^8 ergs/cm^2 sec, and if a substantial fraction of this energy is carried in the form of Alfvén waves, then the rate of dissipation of the waves is slower than the rate at which energy is injected. Since the waves must propagate along the magnetic field and cannot reenter the photosphere, they must remain within the plage; hence, the magnetic and kinetic energy in a small-scale motion (either waves, turbulence, or high-energy particles) must increase with time, eventually causing disruption of the volume when the small-scale energy density exceeds the energy in the mean field. It is believed that the unusually broad wings in the emission lines represent evidence of this phenomenon. The accumulation of waves is manifested as a resonance which occurs initially only at discrete locations in the magnetic field, but later is expected to involve the whole flare volume. The response of a typical volume of flare dimensions due to a trapping of the normal wave supply to the corona is studied through use of the virial equation. For magnetic fields typical of a plage, the region expands in a time scale of 10^3 to 10^3 sec, with a velocity in the neighborhood of 10 to 20 km/sec. Small-scale velocities within the region, however, have reached 100 to 300 km/sec, indicating that almost all the energy in the flare resides in small-scale forms. The energy density of the flare region exhibits a behavior much more explosive than the expansion rate. There is a rapid rise to maximum in 10^2 sec or less, and a slow subsequent decline taking about 10^3 to 10^4 sec due to the dilution of energy caused by expansion of the region. The predicted temporal behavior of the energy density coincides qualitatively with the light curves observed during flares, and it is suggested that the rise and decline of the energy density is to be associated with the optical flare. The total flare is defined as the time required for the energy density of the chromosphere and corona to return to the pre-flare state. During this time (about one hour) a large flare can derive the necessary 10^{32} ergs for normal photospheric energy output. (auth)

15304 THE STARTING FREQUENCIES OF TYPE III BURSTS. Malville, J. McKim (High Altitude Observatory, Boulder, Colo.). Solar Phys., 2: 484-90(Dec. 1967).

During the period 1960 to 1966 the monthly averages of the starting frequencies of type-III bursts declined with the level of solar activity and reached a minimum near the minimum of the solar cycle in 1964. The electron densities corresponding to the observed starting frequencies are close to those expected at the base of the K corona. It is shown that sufficient free–free absorption may occur in the corona above the appropriate plasma levels to account for the observed behavior of the starting frequencies of the bursts. The daily variation in the starting frequencies is attributed to structural variation of the inner corona. Quiescent prominences may be responsible for establishing periods of anomalously low-starting frequencies. (auth)

15305 OBSERVATIONS OF THE SPATIAL STRUCTURE OF INTERSTELLAR HYDROGEN. I. HIGH-RESOLUTION OBSERVATIONS OF A SMALL REGION. Heiles, Carl (Princeton Univ., N. J.). Astrophys. J., 15: Suppl. Ser., 136, 97-130(Dec. 1967).

The 21-cm line radiation emitted by low-velocity neutral hydrogen has been mapped in detail in the region bounded by $l^{II} \simeq 100° - 140°$, $b^{II} \simeq 13° - 17°$, using the 300-foot telescope and the 100-channel autocorrelation receiver at the National Radio Astronomy Observatory. The beam width of the antenna at this wavelength is 10′, the velocity resolution about 1 km/sec, the total range of velocities observed about 50 km/sec, and the antenna temperature sensitivity about 1°. Several considerations lead to the adoption

of a common distance of 500 pc to all of the hydrogen as a reasonable approximation. The gas can be resolved into three physical components: a diffuse, smooth background, contributing about ¾ of the integrated 21-cm emission; and two large sheets of gas having relative motion in which the hydrogen density is probably about two atoms/cm³, which contain structure. In part of the region the sheets coexist in space and velocity. The velocity of each sheet is highly ordered over distances of tens of degrees on the sky; linear structures characterized by no hydrogen ("rifts") run across each sheet. The disturbance responsible for the rifts probably exists in sheetlike form, too. The present observations do not correspond at all with the predictions of the "standard cloud model." Concentrations of gas which one might call clouds are present in the sheets, but usually their density is no larger than twice the surrounding density; about ten of these objects exist, some of which are so large that the tidal force of the galactic gravitational field must affect their equilibrium. Especially prominent are the "group clouds" which are similar to classical "interstellar clouds" but which are clumped together into two groups; much of the large velocity dispersion of these objects may result from systematic radial motion. No enhanced 21-cm emission is observed at positions of dense dust clouds; this is attributed to the presence of cold or molecular hydrogen in these objects, which are bound by self-gravitation if the optical extinction is from classical dielectric spheres. Small concentrations of near stellar mass distinctly different from the above concentrations, are observed in profusion; but since they are small they contain only about 10% of the mass of the sheets. Typical radii of these "cloudlets" are a few parsecs; excess densities are not large, about a factor 2. The upper limit to the kinetic temperature implied by their velocity width is about 100°K. The highest brightness temperature observed in the region is 130°, equal to the commonly accepted value for the kinetic temperature in the galactic plane; the line profile does not appear saturated. This, together with previous determinations of kinetic temperature, implies the existence of large temperature variations in the interstellar gas. The decrease of the number of hydrogen atoms/cm² in the line of sight with increasing galactic latitude is much faster than 1/sin b; the decrease near latitude 28° is almost discontinuous. The conclusion follows that in this region little hydrogen exists in the neighborhood of the Sun. (auth)

15306 X RAYS FROM SOURCE 3C 273. **Argyle, Edward (Dominion Radio Astrophysical Observatory, Penticton, B. C.). Science, 159: 747(Feb. 16, 1968).**

Friedman and Byram (Science, 158: 257(1967)) describe a high-altitude x-ray experiment and give the results obtained from a single scan through the Virgo region. In addition to M 87, the authors claim to have detected four other x-ray sources, one of them in the direction of 3C 273. They do not give standard deviations for their calculated flux values, and it is therefore necessary to make an estimate of the statistical significance of the results. This can be done in a variety of ways, three of which are briefly described. (W.D.M.)

15307 INTERSTELLAR AND INTERPLANETARY PLASMAS. **Cowling, T. G. Quart. J. Roy. Astron. Soc., 8: 130-41(June 1967).**

Interstellar and interplanetary plasmas are discussed in relation to the methods of observation and taking measurements. Radio-astronomical techniques and artificial satellites were used. (UK)

15308 NEUTRON MONITOR OBSERVATIONS OF HIGH-ENERGY SOLAR PARTICLES DURING THE NEW CYCLE. **Baird, G. A.; Bell, G. G.; Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). Solar Phys., 2: 491-501(Dec. 1967).**

After a lapse of five years, the first solar events in which particles were emitted with sufficiently high energies to produce intensity enhancements in ground-based neutron monitors occurred on July 7, 1966, and January 28, 1967. Although the magnitude of the first of these increases was too small (<2%) to permit detailed analysis, the later event, which exceeded 18% at sea-level stations in the polar regions, displayed unusual characteristics. The January 28 event is anomalous in that either it represents the first observation of solar particles reaching the earth from the back side of the Sun, or it is associated with a feeble flare (1–) in the unfavored eastern hemisphere of the visible disk. The propagation of solar particles in this event was evidently controlled by a diffusion mechanism, and the observations are consistent with predictions based on alternative theoretical models of this process. (auth)

15309 PHOTOELECTRIC MAGNITUDES AND COLOURS OF SOUTHERN STARS. II. **Cousins, A. W. J.; Lake, R.; Stoy, R. H. Roy. Observ. Bull., No. 121, E3-E53(1966).**

Photoelectric observations of stellar magnitudes and colors made at the Cape Observatory in the period 1961–1963 are combined into a single catalogue containing entries for over 2000 stars. This catalogue is essentially an extension of that given in Royal Observatory Bulletin No. 64 and the results are on precisely the same system, i.e., the V, B–V, U–B, and $(U-B)_C$ system defined in Royal Observatory Bulletin No. 49. At least four observations contribute to each entry and, except for some of the faintest stars, the internal probable error of the catalogue entries does not exceed ±0.01 m. (auth)

15310 CHANGES IN STORM ACTIVITY IN THE SOLAR CYCLE. **Kleymenova, Z. P. Meteorol. Gidrol., No. 8, 64-8(1967). (In Russian).**

The connection between storms and solar activity is considered as part of the general problem of variations in worldwide storm activity and the constancy of the currently assumed average frequency of lightning discharges for the entire earth (100 per second). The average annual number of stormy days for a solar cycle is plotted, and the results are compared with changes in intensity of radio noise. Such analyses indicate that the view concerning variation of storm activity with sunspot intensity may be false. According to data for number of days having storms (at more than 2000 stations around the world) and according to intensity of atmospheric noise (for the period 1957–65) it is definitely concluded that, on a worldwide scale, changes in storm activity are completely out of phase (not in phase) with changes in solar activity. World maps indicating storm activity and solar activity show much greater areas where the two are out of phase than where they are in phase. It must be concluded that the relations are not precisely the same for all parts of the globe. (ATD)

15311 LYMAN-α RADIATION FIELD IN THE SOLAR CORONA. **Rompolt, B. Acta Astron., 17: 147-54(1967). (In Russian).**

The results of computing the mean intensity profiles of the photospheric radiation in the Hα line are calculated for 45 different heights above the photosphere with the Elliott-803 computer, taking into account limb darkening. (ATD)

15312 PARKER'S SOLAR WIND THEORY. **Konyukov, M. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 169-76(1967).**

Translated from Geomagn. Aeron., 7: 217-25(1967).

The influence of a polytropic heat source on the stationary, spherically symmetric flow of plasma out of the Sun is examined. It is shown that the appearance of flow with properties that are not at variance with observations is possible only when the heat source is sufficiently extended. (auth)

15313 MAGNETIC FIELDS IN SPACE ACCORDING TO A STUDY OF THE MAGNETIC PROPERTIES OF METEORITES. **Gus'kova, E. G.; Pochtarev, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 245-50(1967).**

Translated from Geomagn. Aeron., 7: 310-16(1967).

The magnetic properties and the results of magnetic purification of stony, stony-iron, and iron meteorites are compared. Two methods of computing thermoremanent magnetization, I_{rt}, are examined and it is shown that the I_{rt} of stony meteorites obeys the general patterns of formation of I_{rt} as a function of the magnetic characteristics established for terrestrial rocks. The parent magnetic fields in which the natural remanent magnetization of meteorites formed are estimated. (auth)

15314 PLUTONIUM WAS HERE. **Stubbs, Peter. New Sci., 37: 295-6(Feb. 8, 1968).**

The evidence of fossil particles tracks in meteorites leaves little doubt of the former existence of natural plutonium in the solar system. The "footprints" of this "extinct" element provide a means of gauging the gestation period of the planets, and of testing theories of the synthesis of the elements. (auth) (UK)

15315 HIGH ENERGY ASTROPHYSICS. VOLUME II. Lectures Delivered at Les Houches During the 1966 Session of the Summer School of Theoretical Physics with a Grant from NATO. **DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967. 344p.**

Four lectures are contained in this volume. Separate abstracts were prepared for each. Topics covered include elementary processes in astrophysics, high-energy nucleosynthesis, accelerating mechanisms and origin of cosmic radiation, and the origin of cosmic rays. (W.D.M.)

For abstracts of individual sections see: 15316, 15317, 15384, and 15385.

15316 ELEMENTARY PROCESSES IN ASTROPHYSICS. **Chiu, H. Y.; Zaidi, Mumtaz H. (Goddard Space Flight Center, New York). pp 1-162 of High Energy Astrophysics. Vol. II.**

DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

This lecture discusses the application of field-theory techniques to some astrophysical problems and the relation between elementary-particle physics and cosmic processes. The basic methods used in quantized field theories to evaluate the thermodynamic properties of stellar matter at stellar temperatures are discussed. Among the most important applications is the evaluation of the production rate of neutrinos. A more conservative approach to cosmological problems is employed, including a treatment of the early evolution of the Universe based on conventional laws of physics and the usual form of the theory of relativity. Such problems as the matter-energy density of the Universe and the symmetry between particles and antiparticles in the Universe are considered. Two reprints are included which deal with the application of neutrino processes to stellar processes. (W.D.M.)

15317 HIGH-ENERGY NUCLEOSYNTHESIS. Reeves, H. (Institut de Physique Nucleaire, Orsay, France). pp 163-226 of High Energy Astrophysics. Vol. II. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

Low-energy nucleosynthesis is reviewed and attention is concentrated on those parts which are well explained by nuclear physics theories. The historical sequence of events from the birth of the Universe to the present is followed. Nuclear physics is covered in those aspects which are relevant to astrophysics. Stellar cosmic rays and meteorites are considered. (W.D.M.)

15318 HIGH ENERGY ASTROPHYSICS. VOLUME III. Lectures Delivered at Les Houches During the 1966 Session of the Summer School of Theoretical Physics with a Grant from NATO. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967. 461p.

This volume is devoted to general relativity and to the problems of extreme densities, in particular to gravitational collapse and the structure of neutron stars. Separate abstracts were prepared for the two sections. (W.D.M.)

For abstracts of individual sections see: 15319 and 15320.

15319 HIGH-DENSITY ASTROPHYSICS. Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Space Flight Center, New York); Arnett, W. D.; Gilbert, A.; Hansen, C. J.; Truran, J. W.; Tsuruta, S. pp 1-258 of High Energy Astrophysics. Vol. III. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

This section contains sections on degenerate matter, thermonuclear reactions in medium and heavy nuclei, approach to nuclear statistical equilibrium, composition of matter near nuclear statistical equilibrium at high densities, composition of matter near nuclear density, neutrino loss mechanisms, the supernova process, white dwarf stars, effects of nuclear forces, cooling and detectability of neutron stars, and vibrations of neutron stars. (W.D.M.)

15320 RELATIVISTIC STELLAR STRUCTURE AND DYNAMICS. Thorne, K. S. (Princeton Univ., N. J. California Inst. of Tech., Pasadena). pp 259-441 of High Energy Astrophysics. Vol. III. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

The basic thermodynamic and gravitational concepts used in the article are presented. A derivation and discussion of the general relativistic equations of stellar structure is given, along with delineations and proofs of some fundamental properties of relativistic stellar models. The theory of the dynamical stability of relativistic stellar models is developed. The above tools are applied to a wide class of hot, degenerate stellar models, to a discussion of the theory of supermassive stars, and to an analysis of configurations of matter near the endpoint of thermonuclear evolution (white dwarfs, neutron stars, hyperon stars). A brief introduction is given to the theory of gravitational collapse to zero volume and infinite density. A full, modern discussion of the Schwarzschild solution of Einstein's vacuum field equations is given along with an introduction to the general relativity versions of Liouville's theorem and of the Boltzmann transport equation. (W.D.M.)

15321 THE MAGNETIC AND RELATED STARS. Proceedings of the Symposium on the Magnetic and Other Peculiar and Metallic-Line A Stars, held at Greenbelt, Maryland, November 8–10, 1965 and the 1965 Helen B. Warner Prize Lecture of the American Astronomical Society, Berkeley, California, December 29, 1965. Cameron, Robert C. (ed.). Baltimore, Mono Book Corp., 1967. 607p. $25.00. (CONF-651157).

This volume represents the proceedings of the international Symposium on the Magnetic and Other Peculiar and Metallic-Line A stars and contains 41 papers covering stellar magnetic fields (theoretical investigations), stellar magnetic fields (observational investigations), magnetic and related stars (evolutionary, photometric, and spectroscopic studies), and related astrophysical problems. (W.D.M.)

15322 QUASI-STELLAR OBJECTS. Burbidge, Geoffrey; Burbidge, Margaret. A Series of Books in Astronomy and Astrophysics. San Francisco, W. H. Freeman and Company, 1967. 247p. $7.50.

This monograph is a summary of the state of knowledge and speculation about quasars as of early 1967. In the early chapters the identification of quasars, their line spectra and continuous energy distribution, their radio properties, and the time variations in the energy radiated are discussed. A brief account of attempts to measure proper motions of quasars is given, followed by a discussion of their distribution in the sky. The nature of the red shifts is considered and an account is given of the empirical models that have proposed to explain the line spectra, the continuous energy distribution, and various correlations that have been found. The relation between properties of quasars and the intergalactic medium is then discussed, as part of the statistics of quasars. In the final chapters theories that have been put forward concerning the nature of quasars and their energy sources are dealt with. (W.D.M.)

15323 INTRODUCTION TO RADIO ASTRONOMY. Jennison, Roger C. New York, Philosophical Library Inc., 1967. 168p.

This introduction to radio astronomy was written in an attempt to bridge the gap between the textbook and the too-popular treatment of an exciting and rapidly expanding science. It is a book that contains a little more on the techniques of radio astronomy than may be found elsewhere, and is for those who are not specialists, but who, none-the-less, seek some real understanding of the subject. (W.D.M.)

15324 NUCLEAR ASTROPHYSICS. A BIBLIOGRAPHICAL SURVEY. Kuchowicz, B. New York, Gordon and Breach, Science Publishers, 1967. 450p. $13.50.

A survey is given on the abundance of chemical elements, nuclear reactions in stars and stellar energy sources, stellar structure and evolution, solar system, novae and supernovae, superdense stellar matter, nucleosynthesis, neutrino emission by stars, origin of cosmic radiation, radio and gamma astronomy, cosmology and cosmogony problems, and related nuclear physics. Twenty-one hundred and one papers are quoted from 1335 to the present. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 14751, 14835, 15679, 15731, 15913, and 16060.

15325 (DESY-67/33) INVESTIGATIONS OF ALUMINUM FILMS WITH SYNCHROTRON RADIATION OF WAVELENGTHS 500 TO 1000 A. A. POLARIZATION DEPENDENT TRANSMISSION AND REFLECTION. B. POLARIZATION DEPENDENT PHOTOEFFECT. Skibowski, M.; Feuerbacher, B.; Steinmann, W. (Munich Univ. (West Germany)); Godwin, R. P. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1967. 51p. Dep.

Measurements of the transmittance and reflectance of Al films as a function of wavelength, polarization, angle of incidence, and film thickness were carried out using synchrotron radiation together with a normal-incidence monochromator for the vacuum ultraviolet spectral region. Measurements were also made of the photocurrent from thin Al cathodes in a windowless electron multiplier as a function of wavelength, polarization, angle of incidence, and film thicknesses. (M.O.W.)

15326 (DESY-67/42) MEASUREMENT OF PHOTOABSORPTION OF THE LITHIUM-HALIDES NEAR THE LITHIUM K EDGE. Haensel, R.; Kunz, C.; Sonntag, B. (Physikalisches Staatsinstitut, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik, Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec. 1967. 9p. Dep.

The fine structure of photoabsorption was measured in LiF, LiCl, LiBr, and LiI near the LiK edge (photon energy ~60 eV). (M.O.W.)

15327 (LA-DC-8508) SELF-CONSISTENT FIELD HARTREE CALCULATIONS FOR ATOMS AND IONS. Larson, Allen C.; Waber, James T. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 98p. Dep. CFSTI.

Calculations of the wave functions, eigenvalues, and values of $\langle r^2 \rangle$ have been carried out for more than 500 different configu-

rations of atoms and ions, using the Hartree model. These calculations cover atomic numbers 1 to 128. The various assumptions used and many of the problems of this type of calculation are discussed. Procedures are suggested to solve the problem of slow convergence encountered with atoms such as Cu. The results for hydrogen-like ions obtained from the programs are compared with analytic numbers. The effect of the convergence criterion on the "stability" of solutions was examined for the series Fe, Ni, Co, and the results are discussed. On the machine used, the IBM 7094, a self-consistent test more stringent than 10^{-5} failed to improve the expectation values significantly. Various effects of changing the assumed electronic configuration are examined. (auth)

15328 (ORNL-TM-1444) AN APPARATUS FOR MEASUREMENT OF ELECTRON ATTACHMENT AND ELECTRON SWARM DRIFT VELOCITIES AT HIGH TEMPERATURES. Hendrick, W. G.; Christophorou, L. G.; Hurst, G. S. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

Thesis. Submitted by W. G. Hendrick to Univ. of Tennessee, Knoxville.

An apparatus built for the study of electron swarm drift velocities and electron attachment to molecules for temperatures ranging from 273° to 473°K was used for the study of electron attachment to SF_6 at thermal energies. The thermal rate of attachment to SF_6 was measured in the temperature range 273° to 473°K and found to be temperature-independent. Thus it is concluded that the electron-attachment cross section for SF_6 at thermal energies varies inversely with the electron velocity when the attachment cross section is assumed to be expressed in powers of the electron velocity. Electron drift velocities in nitrogen and ethylene were also measured over the temperature range 273° to 473°K and found to decrease as temperature increases. An analysis of the temperature dependence of the w data in C_2H_4 yielded a velocity-independent cross section for momentum transfer equal to $(4.37 \pm 0.26) \times 10^{-16}$ cm^2 at thermal energies. This finding was further used to obtain information on the scattering of thermal electrons from polar molecules. (auth)

15329 (UCRL-17717) QUASI-ELASTIC STOPPING CROSS-SECTION FOR VERY LOW ENERGY IONS. Cao-Xuan-Chuan (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 7, 1967. Contract W-7405-eng-48. 15p. (CONF-671202-1). Dep. CFSTI.

From Meeting of the American Physical Society, Pasadena, Calif.

The energy loss by quasi-elastic stopping of very-low-energy ions passing through matter is discussed and the concept of close and distant collisions is introduced. The expression of the stopping cross sections is derived and agrees well with the results of previous authors as far as the nuclear effect is concerned. However, the agreement is only partial for the electronic effect. (auth)

15330 (UCRL-18040) ENERGY LEVEL CALCULATIONS FOR SINGLY IONIZED HAFNIUM. Mehlhorn, Rolf (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 147p. Dep. CFSTI.

Thesis.

The parametric theory of atomic structure, developed by Racah, was used to derive formulas for matrix elements, including those of configuration interaction not hitherto available in the literature. These formulas were incorporated into a series of computer codes for calculating matrix elements, energy levels, g values, and intensities. The programs were designed to deal with the commonly occurring configurations l^n, $l^{n-1}l'$, and $l^{n-2}l'l''$. With the aid of these programs an analysis of Hf II was conducted. The odd parity levels could be described with a mean error of 143 cm^{-1} for 56 energies, corresponding to about 0.5% of the configuration width. However, many calculated g-values did not agree with the observations. Therefore a new least squares fit, utilizing both the g-values and energy levels was developed. With this fit the mean error for the g-values was reduced from .100 to .023, but the error in energies rose to 453 cm^{-1} for 62 energies. To investigate the eigenvector errors, intensities were calculated. With the eigenvectors of the energy calculation no reasonable agreement was found between calculated and observed intensities. The theoretical intensities were considerably improved by assuming a crude model for configuration interaction. An admixture of excited configurations into the known eigenvectors, depending linearly on the energy of the known level, was postulated. In the final result the mean error for 300 observed transitions was about 50%, due to large experimental errors. (auth)

15331 COMPTON EFFECT ON A SPINLESS SYSTEM AT LOW ENERGIES. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 79-80(1967). (In Russian).

By using the property of cross symmetry it is shown that the scattering cross section of photons on a spinless system with the use of cubic terms for the photon frequency is expressed by two unknown parameters, which can be interpreted as the electric and magnetic polarizabilities of the scatterer. An expression is given for the cross section of the Compton effect on a spinless system in the laboratory system of coordinates. This method is simpler and more general than other methods used to calculate the amplitudes of the Compton effect on systems having spins of $\frac{1}{2}$ and 0. (TTT)

15332 INVESTIGATION OF SPUTTERING OF TITANIUM BY 3- TO 9-keV POSITIVE NITROGEN, OXYGEN, AND ARGON IONS. Kurbatov, O. K. Zh. Tekh. Fiz., 37: 1814-17(Oct. 1967). (In Russian).

The ion beam was directed normally onto a $10 \times 10 \times 0.1$ mm^3 target of polycrystalline titanium and, after traversing the target, was caught and measured in a Faraday cup. The loss of mass of the target was measured with an automatic vacuum microbalance having a sensitivity of 2.5 μg. The beam current ranged from 10 to 50 μA, and the ion flux density on the target, from 8×10^{13} to 40×10^{13} ion/cm^2 sec. A vacuum of 2×10^{-3} mm Hg was maintained in the target chamber. The sputtering coefficient was independent of the beam current, and in the case of argon ions it increased from about 1.2 to 2.0 atom/ion as the ion energy was increased from 3 to 9 keV. The sputtering coefficients for nitrogen and oxygen ions were considerably lower than those for argon ions, and they increased less rapidly with increasing ion energy. At conditions corresponding to the operation of magnetic discharge pumps at 5×10^{-4} mm Hg (i.e., for 3- to 4-keV incident ions) the ratio of the sputtering coefficient for nitrogen ions (0.6 atom/ion) to that for oxygen ions (0.36 atom/ion) was 1.7; this is equal to the ratio of the pumping speeds of magnetic discharge pumps for the two gases. (ATD)

15333 NEUTRALIZER OF INTENSE ION BEAMS. Butusov, V. I.; Mukhin, P. A.; Svishchev, V. S. Zh. Tekh. Fiz., 37: 1818-24(Oct. 1967). (In Russian).

Two supersonic gas jet charge exchange chambers are described for neutralization of intense (of the order of 1 A) beams of fast (up to 100 keV) protons and hydrogen molecule ions to provide beams of fast neutral hydrogen atoms for injection into the Ogra-II machine. The first chamber employed a supersonic jet of CO_2 as charge exchange target. After unsatisfactory experience with an elongated Laval nozzle, whose efficiency was greatly reduced by the formation of a thick boundary layer on the wall of the expanding portion of the nozzle, a sonic (Mach 1) nozzle was employed, from which the gas issued directly into the vacuum through a 250×0.2 mm^2 slit. The jet velocity reached Mach 5 at some 20 slit widths from the nozzle. The ion beam entered the charge exchange chamber and, after traversing the target, left it, through windows with areas exceeding 200 cm^2 each. The gas was condensed on the liquid-nitrogen-cooled walls of the chamber and was further discouraged from entering the high-vacuum portion of the system by a set of baffles. It was possible thus to maintain a pressure of some 10^{-3} mm Hg in the gas target and 10^{-6} mm Hg in the high-vacuum region. With a CO_2 pressure of about 18 mm Hg behind the nozzle and a gas flux of 0.6 g/sec it was possible to achieve a hydrogen atom concentration of 20% in a beam of 100-keV protons. The greatest difficulty experienced with the CO_2 target arose from dissociation of the CO_2 by the fast protons, the cross section for which was estimated as $(5 \text{ to } 10) \times 10^{-15}$ cm^2. The second charge exchange chamber employed a Mg vapor target issuing from a 250×1 mm^2 slit and condensing on the water-cooled walls of the chamber. The equilibrium concentration of hydrogen atoms in a 25 keV proton beam after traversing an approximately 3×10^{16} atom/cm^2 thick Mg vapor target was 60%. It is concluded from the present results and data in the literature that magnesium vapor is the most suitable material for a gaseous charge exchange target for 20-keV protons. (ATD)

15334 ON APPROXIMATE EVALUATION OF CHARACTERISTICS OF COMPRESSED ATOMS WITH THE AID OF THE THOMAS–FERMI STATISTICAL MODEL. Shul'man, G. A. Zh. Tekh. Fiz., 37: 1897-1903(Oct. 1967). (In Russian).

The author discusses the accuracy of different methods of calculating on the basis of the Thomas–Fermi statistical model the order in which the different electron shells are filled in highly compressed atoms. Such calculations for the case of zero pressure were first performed by Fermi. Calculations for compressed atoms were first undertaken by Gombas (Acta Phys. Hung., 7: 365(1957); 8: 315(1958)), who calculated the number of electrons with a given orbital angular momentum quantum number and employed the method of Jensen and Luttinger (Phys. Rev., 86: 907(1952)) to calculate the mean square value of the angular mo-

mentum. The author and Izmailov (Zh. Tekh. Fiz., 35: 1889(1965); 36: 405(1966); and 36: 2131(1966)) performed calculations by different methods, including and neglecting the exchange correction and the second order correction to the Fermi kinetic energy in the statistical model, and in some cases employing the Lentz–Jensen direct variational method. All these methods are discussed and their results are compared with each other, with the experimental data of Ryabinin (Dokl. Akad. Nauk., SSSR, 104: 721(1955); Fiz. Metal. Metalloved., 2: 225(1956)) on the atomic volumes of several elements at a pressure of 5×10^5 atmospheres, and with the more accurate calculation of Sternheimer (Phys. Rev., 78: 235(1950)) of the pressure at which the 4s to 3d transformation takes place in potassium. The calculations are in reasonably good agreement with the experimental atomic volumes and in very good agreement with the calculation of Sternheimer. It is concluded that calculations employing the Lentz–Jensen variational method and in which the boundary condition of Wigner and Seitz (Phys. Rev., 43: 84(1933); 46: 509(1934)) is not fulfilled can give qualitative, and with a certain degree of reliability, quantitative, results concerning the populations of electron shells. (ATD)

15335 ANOMALOUS ENERGY DEPENDENCE OF THE POLARIZATION OF THE RADIATION OF ATOMS EXCITED BY AN ELECTRON BEAM. Sholin, G. V. Dokl. Akad. Nauk SSSR, 175: 1256-8(Aug. 21, 1967). (In Russian).

No satisfactory correlation has as yet been found between the polarization arising when mercury atoms are bombarded by an electron beam, and the energy of the incident electrons. It was therefore attempted to clarify the observed dip of the polarization of the radiation at energies close to the threshold value within the framework of the semiclassical collision concept. It was found that the anomalous behavior of polarization is due to pivoting of the axis of quantification in the direction beyond the emitted electrons. The theoretical considerations are based on the excitation of the atomic level of a given energy and the interaction of the atomic electron with a classical particle carrying a given charge. An expression is derived, indicating the cause of the polarization of the radiation as a function of the electron energy. It is suggested that the adiabatic character of the collisions be experimentally verified; this would involve a measurement of polarization of the radiation by the coincidence method, not with respect to the direction of the incident but with respect to the scattered electrons. (TTT)

15336 APPLICATION OF ATOMIC BEAMS TO ELEMENTARY-PARTICLE AND NUCLEAR PHYSICS. Commins, Eugene D. (Univ. of California, Berkeley). Contract W-7405-eng-48. Annu. Rev. Nucl. Sci., 17: 33-72(1967). (UCRL-17435).

The most significant recent developments in the application of atomic-beam experiments to nuclear and elementary-particle physics are reviewed. Discussions are included on precise and critical tests of quantum electrodynamics by measurement of radio-frequency spectra of hydrogenic atoms; atomic-beam tests of symmetry and invariance principles; and use of atomic-beam magnetic-resonance methods for determination of nuclear spins, hyperfine structures, isotope shifts, and static multipole moments. (S.F.L.)

15337 EVIDENCE OF AN ELECTRON ORIENTATION IN THE EXCITED STATES OF ^{3}He OBTAINED FROM A NUCLEAR ORIENTATION IN THE GROUND STATE. Grossetete, Francoise; Laloe, Franck; Cohen-Tannoudji, Claude; Brossel, Jean (CNRS, Paris). Compt. Rend., Ser. A and B, 265: 1247-50(Nov. 27, 1967). (In French).

A new orientation procedure of the excited states of atoms in which the nucleus was first oriented in the ground state is described. The method is applied to ^{3}He. (tr-auth)

15338 ELASTIC RESONANCE IN ELECTRON–HYDROGEN SCATTERING. Banerjee, S. N.; Jha, R.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 41: 482-5(July 1967).

The singlet s-wave phase shifts in the elastic scattering of slow electrons by atomic hydrogen were calculated in the energy range below the threshold for the excitation of second quantum level (10.2 eV) by Hulthén's variational method. The exchange effect was allowed for and the polarization effect was considered through the process of virtual excitation to 2S and $2P_0$ levels. A resonance level at 9.55 eV was obtained which agrees favorably with the recent experimental findings and the results of other theoretical calculations. (auth)

15339 METHOD OF DETERMINATION OF MOST IMPORTANT PHYSICAL CONSTANTS AND THEIR NUMERICAL VALUES. Szpilecki, Jozef. Postepy Fiz., 18: 672-89(1967). (In Polish).

Methods of determination are given for the following: (1) the fine structure constant, (2) the magnetic moment of the proton in nuclear magnetons, (3) the Faraday constant, and (4) the gyromagnetic coefficient of the proton. (M.O.W.)

15340 COLLISIONAL DISALIGNMENT OF EXCITED NEON ATOMS. Haensch, T.; Odenwald, R.; Toschek, P. (Univ., Heidelberg). Z. Phys., 209: 478-96(1968). (In German).

Variations of the number densities of excited Neon $2p_4$ and $3s_2$ levels were induced by interaction of a low pressure Ne or He–Ne discharge with the linearly polarized 633-nm light of a He–Ne gas laser. They are associated with partial alignment of those atoms having undergone a stimulated transition and consequently with anisotropy and polarization of the spontaneous radiation emitted by the discharge. From its gradual decrease at increasing pressure, depolarization cross sections of $Q^*_{Ne^*-Ne}$ (157 ± 12) $\AA^2$ and $Q^*_{Ne^*-He}$ = (63 ± 7) $\AA^2$ at mean relative velocity are derived. Comparison with values calculated by application of an adiabatic theory including sudden approximation yields good agreement in the case of Ne*–He interaction and a discrepancy of 35% in the case of Ne*–Ne interaction. (auth)

15341 COMPARISON MEASUREMENTS OF TOTAL ALKALI METAL–RARE GAS CROSS SECTIONS. von Busch, Fr.; Strunck, H. J. (Univ., Bonn). Z. Phys., 209: 474-7(1968). (In German).

Total scattering cross sections of Na and Cs on Ar and Kr and of Rb on Kr have been measured relative to the corresponding K cross sections by a fast direct comparison technique. From the data ratios, van der Waals constants are derived, which show good agreement with recently published semiempirical values. (auth)

15342 STUDY OF $H_2^+ + H_2 \rightarrow H_3^+ + H$ USING MERGING BEAMS. Neynaber, R. N.; Trujillo, S. M. (General Dynamics/Convair, San Diego, Calif.). Phys. Rev., 167: 63-6(Mar. 5, 1968).

A merging-beams technique was used to determine cross sections for the reaction $H_2^+ + H_2 \rightarrow H_3^+ + H$ as a function of interaction energy W. Cross-section measurements at W were accompanied by measurements at 1 eV so that ratios were obtained for cross sections, Q_W/Q_1. These ratios were determined for 0.1 eV ≤ W ≤ 10 eV. Some information about the reaction was also obtained for W ≤ 0.03 eV. An absolute cross section was determined for W = 1 eV. Its estimated error is considerably larger than errors associated with the cross-section ratios. Gioumousis and Stevenson (GS) predict a linear dependence of the cross section on $W^{-\frac{1}{2}}$. On a Q_W/Q_1 versus $W^{-\frac{1}{2}}$ plot, a straight line can be fitted, within experimental error, to these values for 0.1 eV ≤ W ≤ 1 eV. This line is in fair agreement with that predicted by GS. On either side of this range, however, our ratios fall below the $W^{-\frac{1}{2}}$ fit. Between 5 and 7 eV our results indicate that, within experimental error, Q_W/Q_1 vanishes. On the high-energy side, such a falloff could perhaps be explained by a spectator stripping model. The cross-section ratios are in general agreement with those obtained from a tandem mass-spectrometer experiment by Giese and Maier, and in rather poor agreement with the results of a single-stage mass-spectrometer experiment by Reuben and Friedman. Lower W's were obtained with the merging-beams technique than with the mass-spectrometer methods. (auth)

15343 MODEL FOR HIGH-ENERGY CHARGE TRANSFER. Mittleman, Marvin H.; Quong, James (Univ. of California, Berkeley). Phys. Rev., 167: 74-80(Mar. 5, 1968).

A one-dimensional model of charge transfer is solved numerically, and the results are compared with standard approximation techniques. At higher energies, a regularity in the phase of the numerical result can be derived by an approximation procedure which in lowest order is the eikonal approximation. This approximation is applied to the problem of charge transfer in proton–hydrogen collisions. The result falls below the usual Born approximation; the limiting value at high energies is 23/48 of the usual Born (Brinkman–Kramers) result. The approximation is also applied to the problem of excitation of atoms by fast protons. The result is an energy-dependent multiple of the Born approximation. The multiplier slowly approaches unity at high energy. A discussion of previous theoretical work relevant to high-energy rearrangement collisions is also presented. (auth)

15344 POLARIZATION OF LYMAN-ALPHA RADIATION FROM H^+– AND D^+–RARE GAS CHARGE-TRANSFER COLLISIONS. Gaily, T. D.; Jaecks, D. H.; Geballe, R. (Univ. of Washington, Seattle). Phys. Rev., 167: 81-9(Mar. 5, 1968).

An experimental determination of the polarization of Lyman-α radiation arising from charge-transfer collisions involving energetic protons and deuterons incident on rare-gas atoms has been made in an energy range from 0.5 to 15 keV proton energy. The polarization was computed from the angular distribution of the emitted radiation with respect to the incident projectile direction. Corrections are made to earlier determinations of the product

cross sections for the collisions. The cross sections are resolved into contributions from magnetic substates, and the qualitative behavior of these contributions is discussed. (auth)

15345 SPONTANEOUS EMISSION IN THE PRESENCE OF A PRESCRIBED CLASSICAL FIELD. Newstein, Maurice C. (Polytechnic Inst. of Brooklyn, N. Y.). Phys. Rev., 167: 89-96 (Mar. 5, 1968).

The effect of the application of a classical driving field on the spectrum of spontaneous emission from a simple physical system is studied. The physical system consists of an ensemble of two-level atoms interacting with a relaxation mechanism. The single Lorentzian line-shape characteristic of the power spectrum of spontaneous emission for the undriven case is split into components by the driving field. This splitting is associated with the establishment of definite phase relations between the corresponding components of the field spectrum. (auth)

15346 ROTATION-VIBRATION INTERACTION IN SCATTERING OF SLOW NEUTRONS BY SPHERICAL-TOP MOLECULES. Buzano, C.; Demichelis, F.; Rasetti, M. (Istituto di Fisica, Turin). Phys. Rev., 167: 97-107(Mar. 5, 1968).

The scattering of slow neutrons from spherical-top molecules of point group T_d is analyzed and discussed taking into account the rotation–vibration interaction. After the introduction of the general formulation for the partial differential cross section, the Hamiltonian of the spherical-top molecule is discussed, and the contribution of the rotation–vibration interaction is considered in detail. By using group-theoretical methods, the rotational–vibrational wave function, and then the total wave function are obtained. Finally, explicit extensive expressions for the intermediate scattering function and the partial differential cross section are derived. (auth)

15347 PHOTO-IONIZATION OF MOLECULES NEAR THRESHOLD. Hernandez, John P. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 167: 108-11(Mar. 5, 1968).

An orthogonalized Coulomb-wave method for the construction of continuum wave functions of molecules is described. Hydrogenic functions of definite angular momentum, which transform according to the irreducible representations of the point group of the molecule, are phenomenologically used as trial functions. Corrections to the trial functions are made by orthogonalizing them to charge rearrangement states of the molecule. The photoionization cross section is obtained by summing over the asymptotic angular-momentum quantum number. The method is exemplified by calculation of the photoionization cross sections of the ground and first excited states of the anthracene molecule in the range of 1.5 eV above threshold. (auth)

15348 VARIATIONAL PERTURBATION METHOD BASED ON THE PRINCIPLE OF MOMENTS. Hu, Chi-yu (California State Coll., Long Beach). Phys. Rev., 167: 112-15(Mar. 5, 1968).

A simple practical variational perturbation method based on the approximate calculation of the moments of the resolvent operator is developed. The method has been applied to the $(1S)^2S$ state of the helium atom. The trial wave functions have been expanded in terms of naturally spaced groups of Hylleraas functions up to 95 terms. The 95 term trial function gives an upper bound of -2.903724305 atomic units to the ground-state energy. Other numerical results have been compared with the 21st-order perturbation energies of Midtdal and other previous calculations. It is found that comparable results can be obtained by the present simple calculation. (auth)

15349 NATURAL EXPANSION OF A MANY-ELECTRON WAVE FUNCTION. Kiang, Hsiao S. (Indiana Univ., Bloomington). Phys. Rev., 167: 116-23(Mar. 5, 1968).

It is shown that the validity of the natural expansion of a many-electron wave function can be established through extremum conditions applied to the diagonal elements of the pure-state density operator constructed from the state vector of the system in a tensor-product space of rank two. From this viewpoint, a variational definition of the two complementary reduced density operators can be given, and deductions can be drawn concerning the properties of the reduced density operators. It is therefore advantageous to regard the related expressions and many of the analytical properties of the reduced density matrices as arising from the solution of a two-space variational problem. A practical method of obtaining this expansion from a wave function of arbitrary form is developed. Functional equations analogous to this type of expansion in a tensor-product space of higher rank and with constraints of pairwise orthogonality are also derived. (auth)

15350 VIBRATIONAL STRUCTURE IN THE DISSOCIATIVE ATTACHMENT OF ELECTRONS IN HYDROGEN. Dowell, J. T.; Sharp, T. E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., 167: 124-7(Mar. 5, 1968).

A series of resonances with spacing 0.3 eV has been observed in the 11.2- to 12.5-eV range of the cross section for production of H^- by dissociative attachment of electrons in H_2. Comparison is made with resonances in the elastic scattering and vibronic excitation. Mechanisms involving vibrational levels of quasibound, excited states of H_2^- are discussed. (auth)

15351 CHARACTERISTIC X-RAY PRODUCTION IN THE ATOMIC K SHELL. Khandelwal, Govind S. (Oak Ridge National Lab., Tenn.). Phys. Rev., 167: 136-8(Mar. 5, 1968). (ORNL-P-3420).

The monopole K-shell form factor is obtained as a function of energy loss and momentum transfer of a charged particle in the Bethe–Born approximation. A comparison is made with the total and Bang–Hansteen cross sections. It is concluded that the monopole Bang–Hansteen cross section accounts for approximately all the deflection effect of the nucleus on the projectile. A crude Coulomb correction formula is found to reproduce the same results as the Bang–Hansteen treatment. (auth)

15352 SPIN-FREE SELF-CONSISTENT-FIELD THEORY. Poshusta, R. D. (Washington State Univ., Pullman); Kramling, R. W. Phys. Rev., 167: 139-47(Mar. 5, 1968).

Hartree–Fock (HF) equations are derived for an N-electron system with a spin-free Hamiltonian. All eigenstates of S^2 are considered for both open- and closed-shell states. States which possess two or more spin-coupling schemes (structures) are treated by mixed-structure kets. A procedure to optimize the mixture of structures is incorporated into the HF equations. A certain mixed-structure ket called the immanant is defined and used to derive the HF equations for a spin-projected Slater determinant. The conventional equations for single determinants and doubly occupied orbitals are derived as special cases. The spin-free method is used throughout: Permutational symmetry of a spin-free ket establishes the corresponding spin eigenvalue. (auth)

15353 HYPERPOLARIZABILITIES OF H^-, He, AND Li^+. Grasso, M. N. (State Univ. Coll., Fredonia, N. Y.); Chung, Kwong T.; Hurst, R. P. Phys. Rev., 167: 1-6(Mar. 5, 1968).

The Ritz variational approximation is used to calculate the energy of the ground state of He, Li^+, and H^- in the presence of a uniform external electric field. The interaction energies are expressed as power series in the electric-field intensity. From the coefficients of these expansions, the polarizabilities α and the hyperpolarizabilities γ are obtained. In this study the hyperpolarizabilities are computed with Hylleraas-type wave functions consisting of 78, 96, 102, and 150 terms. The convergence of α and γ are satisfactory for He and Li^+, but not for H^-. For H^- it is suggested that in order to obtain proper convergence one would need to include more terms in the wave function than would be tractable for our computer. Thus, a different type of function should be used for this ion. The 150-term wave functions gave 169, 1.383, and 0.1925 atomic units (a.u.) for the polarizabilities of H^-, He, and Li^+, respectively. This 150-term function also gave 1.74×10^7, 42.8, and 0.244 a.u. for the hyperpolarizabilities of these same atoms. It is suggested from a study of the convergence of α and γ as more terms are included in the wave function, of the accuracy of the computed α's, and of the free atom energies that the computed γ results are correct to within a few percent or better for He and Li^+, but that the γ computed for H^- is unreliable. The only available measurement of γ, for these ions, gave 51.6 ± 7.9 a.u. for the helium atom. (auth)

15354 VARIATION PROCEDURE FOR MULTICHANNEL SCATTERING PROCESSES. Weare, John H.; Thiele, Everett (Johns Hopkins Univ., Baltimore). Phys. Rev., 167: 11-13 (Mar. 5, 1968).

A variation iteration procedure is described for nonreactive multichannel scattering processes. Its essential features include the expansion of the trial function in terms of the eigenfunctions of a zeroth-order Hamiltonian; the use of the zeroth-order Green's function to impose the correct outgoing behavior on the trial function; and further improvement of the transition matrix element by iteration. The procedure is applied to a problem in atomic–molecular energy exchange. (auth)

15355 AUTO-IONIZATION IN MOLECULAR SYSTEMS. Russek, A. (Univ. of Connecticut, Storrs); Patterson, M. R.; Becker, R. L. Contract W-7405-eng-26. Phys. Rev., 167: 17-25(Mar. 5, 1968). (ORNL-P-3423).

When one of the electrons in a diatomic molecule is highly excited, the molecular system is, in many respects, similar to a hydrogen atom; a single electron moves in the field of a small, singly charged core. These states, called Rydberg states of the

diatomic molecule, can essentially be characterized by hydrogenic quantum numbers n and l, provided that n is large enough so that the orbital radius of the Rydberg electron is large compared to the dimensions of the ion core. However, unlike the hydrogen atom, the ionic core generates not only a Coulomb field, but higher multipole potentials as well. In addition, the ionic core can be vibrationally and rotationally excited with excitation energies greater than the binding energy of the Rydberg electron. When this happens, auto-ionization can occur. This process is very similar to the nuclear internal-conversion process in which an excited nucleus, instead of emitting a γ ray, de-excites by giving up its energy directly to an atomic electron. By taking advantage of the similarity between the autoionization and internal-conversion processes, auto-ionization lifetimes for Rydberg states of H_2 and HD are calculated. These results are compared with experimental results and with those obtained from an alternative approach. (auth)

15356 PRODUCTION OF H ATOMS IN THE 3s STATE BY THE DISSOCIATION OF FAST H_2^+ AND H_3^+ PROJECTILES ON IMPACT WITH H_2, He, Ar, AND Ne. Hughes, R. H.; Kay, D. B.; Stigers, C. A.; Stokes, E. D. (Univ. of Arkansas, Fayetteville). Phys. Rev., 167: 26-9(Mar. 5, 1968).

Absolute cross sections have been determined for the production of hydrogen atoms in the 3s state by the dissociation of fast (20 to 120 keV) H_2^+ and H_3^+ projectiles on impact with H_2, He, Ar, and Ne. A cross section has also been determined for 100-keV H_2^+ impact on N_2. For 100-keV H_2^+ impact on these gases, the production of atoms in the 3s state represents about 3% of the reaction $H_2^+ \rightarrow H^+ + H$. (auth)

15357 INTERACTION POTENTIAL BETWEEN THE GROUND STATES OF H AND H^-. Chen, Joseph C. Y.; Peacher, Jerry L. (Univ. of California, San Diego, La Jolla). Phys. Rev., 167: 30-8(Mar. 5, 1968).

An investigation of the interaction potential for H and H^- in both ungerade and gerade modes is carried out by a semiempirical method in which the recently observed isotope effect in dissociative attachment of electrons to hydrogen molecules is used. The interaction obtained is complex, and the imaginary parts of the interaction account for electron emissions during the course of the interaction. A comparison of the present result with other calculations is presented. The isotope effect in dissociative attachment is also discussed. It is shown that the ratios of the survival probabilities alone do not provide an adequate approximation for the isotope effect. (auth)

15358 LIFETIME OF A NEGATIVE HELIUM ION. Nicholas, D. J.; Trowbridge, C. W.; Allen, W. D. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 167: 38-42(Mar. 5, 1968).

The lifetime of a negative ion of helium produced from He^+ by charge exchange in helium gas is measured and found to be 18.2 ± 2.7 μsec. This is consistent with the lower limit of 10 μsec previously determined. Total loss cross-section measurements in the energy range 20 to 70 keV are reported and compared with a previously published value at 17.5 keV. An investigation is also made of the destruction of the negative ions by thermal photons; this is found to be negligible at the temperatures involved, enabling an upper limit of 2.0×10^{-15} cm² to be set on the photodetachment cross section of He^-. (auth)

15359 IONIZATION OF H(1s) NEAR THRESHOLD. McGowan, J. William; Clarke, E. M. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 167: 43-51(Mar. 5, 1968).

An experimental study of the threshold of ionization of H (1s) has been made. The electron-impact spectrometer used has an electron-energy resolution ≤0.06 eV. For atomic hydrogen, it has been demonstrated that for ~0.4 eV above threshold, the cross section for ionization is a nonlinear and complicated function of the electron energy. The form of the cross section approaches a $(E_e - IP)^{1.13 \pm 0.03}$ power law, although within 0.05 eV of threshold a higher power law would be consistent with our data. Above 0.4 eV and for somewhat less than 3 eV, a linear law more accurately describes our result. The slope of the linear portion of the cross section is in good agreement with other experiments, but in disagreement with theory. The intercept of the linear extrapolation of the straight-line portion with the energy axis is 0.032 ± 0.005 eV above threshold. (auth)

15360 DIRECT AND AUTOIONIZATION OF H_2 NEAR THRESHOLD. McGowan, J. William; Fineman, M. A.; Clarke, E. M.; Hanson, H. P. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 167: 52-60(Mar. 5, 1968).

In experiments involving the collision of electrons with H_2 ($^1\Sigma_g^+$, $v = 0$,K), the ionization-efficiency curve of H_2^+ shows no structure which can be obviously related to the direct vibrational spectrum of H_2. In the first-derivative spectrum, however, the major peaks correspond to the major peaks in the photoionization spectrum, which strongly suggests, for allowed transitions, a one-to-one correspondence between $d\sigma_e/dE_e$ and $\sigma_{h\nu}$. Other peaks no doubt are associated with auto-ionizing states of H_2 which can only be reached through channels normally forbidden to photoexcitation. The major valleys can be related to the direct vibrational-excitation thresholds. From these experiments and other published results, we believe that the auto-ionizing lifetime τ_a for many states may be long. (auth)

15361 CORRELATION ENERGIES OF THE LITHIUM SEQUENCE. Chisholm, C. D. H. (Univ. of Glasgow); Dalgarno, A.; Innes, F. R. Phys. Rev., 167: 60-2(Mar. 5, 1968).

The nonrelativistic eigenvalues of the $1s^22p\ ^3P$ states of the lithium sequence are calculated to be $E(Z) = -1.125Z^2 + 1.093526\,14Z - 0.527\,171\,36 + O(Z^{-1})$ au, where Z is the nuclear charge; and the energy of the $1s^22p\ ^3P - 1s^22s\ ^2S$ transition is calculated to be $\Delta E(Z) = 0.070\,720\,93Z - 0.119\,022\,37 + O(Z^{-1})$ au. For large nuclear charges, the addition of a 2p electron to the $1s^2\ ^1S$ core increases the magnitude of the correlation energy by 0.30 eV to give a value of 1.57 eV, most of which arises from the electron-pair energies. (auth)

15362 GROUND STATE OF THE $(p-\mu-p)^+$ MOLECULE ION. Delves, L. M.; Kalotas, T. (Univ. of Sussex, Eng.). Aust. J. Phys., 21: 1-6(Feb. 1968).

This paper gives the results of a variational calculation using a 100-term wavefunction on the ground (para) state of $(p-\mu-p)^+$, including the effects of the finite proton mass. The energy found is sensitive to the muon mass; with $m_\mu = 206.77\ m_e$, $(B.E.)_{p\mu p}$ is found to be 253.14 ± 0.01 eV. Results are also given for the muon–proton overlap, and for a number of other geometric averages of the wavefunction. (auth)

15363 COLLISION BROADENING OF SPECTRAL LINES. Parsons, R. W.; Metchnik, V. I.; Dyne, R. J. (Univ. of Queensland, Brisbane). Aust. J. Phys., 21: 13-20(Feb. 1968).

The shape of a collision-broadened spectral line depends on the assumptions made about the collision processes involved. If the collision cross section varies inversely as the relative speed of the colliding molecules, the half-width to the half-power points and to the points of steepest slope should be $1/2\pi\bar{\tau}$ and $1/(2\sqrt{3})\pi\bar{\tau}$ respectively, where $\bar{\tau}$ is the mean interval between line-broadening collisions. It is shown that, in a gas of "hard-sphere" molecules, the shape of the line is modified and the above half-widths are reduced by 6.4 and 9.7% respectively. While it is not suggested that gas molecules behave entirely as hard spheres, it is suggested that some deviations from the Van Vleck–Weisskopf–Lorentz shape may occur, and that it may be possible to detect these deviations experimentally. (auth)

15364 ELECTRON TRANSPORT COEFFICIENTS IN HYDROGEN AND DEUTERIUM. Crompton, R. W.; Elford, M. T.; McIntosh, A. I. (Australian National Univ., Canberra). Aust. J. Phys., 21: 43-63(Feb. 1968).

Measurements were made of the drift velocity W and the ratio of diffusion coefficient to mobility D/μ for low-energy electrons in deuterium at 77°K, and of D/μ in hydrogen at 77 and 293°K. Tabulated data are given for D/μ within the range $2 \times 10^{-20} \leq E/N \leq 1.2 \times 10^{-16}$ V cm² and for W within the range $8 \times 10^{-20} \leq E/N \leq 9.5 \times 10^{-17}$ V cm². The low-temperature results show a considerably reduced scatter when compared with previously published data and are of an accuracy comparable with the results of recent measurements made at room temperature. The data obtained complement those of Lowke and of McIntosh, thus completing a set from which a more accurate determination of low-energy elastic and inelastic cross sections can be made. (auth)

15365 EFFECTIVE CROSS SECTIONS FOR COLLISION PROCESSES BETWEEN MOLECULAR OXYGEN AND SLOW ELECTRONS. Takayanagi, Kazuo; Takahashi, Tan. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 3: 521-47(July 1967). (In Japanese).

A review is given of available cross-section data for collision processes between molecular oxygen and electrons with collision energies below 100 eV. Elastic scattering, attachment, rotational and vibrational transitions, and electron excitation and ionization are considered. The experimental generalized oscillator strengths reported by Lassettre and his collaborators are used to calculate the Born cross section for some electron excitation and ionization processes. (IAA)

15366 X-RAY SCATTERING IN LIQUID ^{3}He. Narahara, Yoshimasa (Univ. of Chicago). J. Phys. Soc. Jap., 24: 169-72(Jan. 1968).

Preliminary measurements of scattering of CuK_α x rays (λ = 1.54 A) from liquid ^{3}He were made at three temperatures 0.65,

1.25, and 2.29°K. The liquid structure factor i(s) + 1 was deduced for each case. The results generally agreed with a theoretical prediction. The distribution function for the liquid is computed by using the Fourier inversion procedure. From this, the number of the nearest neighbors and the distance of closest approach of two atoms in the liquid are estimated to be about 7 atoms and 2.3 Å, respectively. (auth)

15367 SCATTERING OF SLOW ELECTRONS BY POLAR MOLECULES. Takayanagi, Kazuo; Itikawa, Yukikazu (Tokyo Univ.). J. Phys. Soc. Jap., 24: 160-8(Jan. 1968).

The cross sections for the scattering of slow electrons by polar molecules are calculated in the approximation of the two-center dipole field, where the dipole field of the molecule is represented by that of a pair of point charges fixed at a distance. The wave equation is expressed in prolate spheroidal coordinates and solved numerically. The dependence of the total and momentum-transfer cross sections on the dipole moment D are shown for several incident energies of the electron. The cross sections have a pronounced peak at a certain value of D; this indicates the presence of a type of resonance. This peak may explain the large cross sections observed experimentally for some polar molecules. The effect of an additional short-range potential is discussed briefly. (auth)

15368 THE HYPERFINE STRUCTURE OF THE $2p\ ^2P$ LEVELS OF LITHIUM. Ardill, R. W. B.; Stewart, A. L. (Queen's Univ., Belfast). J. Phys., A, 92: 296-300(Oct. 1967).

The hyperfine coupling constants of the $1s^22p^2P_{\frac{1}{2},\frac{3}{2}}$ states of lithium are calculated, using the 45-configuration wave functions of Weiss (Astrophys. J., 138: 1262-76 (1963)). Excellent agreement with experiment is obtained for $A_{\frac{1}{2}}$. The calculated value of $A_{\frac{3}{2}}$, however, appears to agree poorly with the numbers derived from recent level-crossing experiments on ^{7}Li. (auth) (UK)

15369 EXCITATION OF N_2^+, O_2^+, AND CO_2^+ BAND BY ELECTRON IMPACT. Nishimura, Hiroyuki (Nagoya Univ., Japan). J. Phys. Soc. Jap., 24: 130-43(Jan. 1968).

The electronic excitation cross sections of the N_2^+ first negative system, the O_2^+ first negative system, and two band systems of CO_2^+ were obtained for the electron energy in the range 80 eV to 1500 eV. The intensity distributions in these molecular band systems were determined under the same conditions. The relative vibrational transition strengths of these band systems and the relative Franck–Condon factors for ionization of these molecules were found to be in essential agreement with theoretical ones given by Bates, by Nicholls and by Wacks. The ratios of the excitation cross sections to the ionization cross sections are 2.5% (N_2^+ 3914 Å), 0.72% (N_2^+ 4278 Å), 0.14% (N_2^+ 4709 Å), 0.3Å (O_2^+ 6026.4 Å), 0.4% (O_2^+ 5631.9 Å), 0.2% (O_2^+ 5973.4 Å), 1.2% (CO_2^+ 2896 Å), 0.4% (CO_2^+ 3247 Å), and 0.4% (CO_2^+ 3254 Å) respectively, which are independent of the electron energy in the energy range concerned. (auth)

15370 CROSS SECTION FOR THE PRODUCTION OF SINGLY IONIZED HELIUM BY ELECTRON IMPACT AT LOW ENERGIES. Brion, C. E.; Thomas, G. E. (Univ. of British Columbia, Vancouver). Phys. Rev. Lett., 20: 241-3(Feb. 5, 1968).

An experimental study was made of the energy dependence of the cross section for the formation of singly charged helium positive ions resulting from inelastic collisions between neutral helium atoms and electrons having a narrow energy bandwidth. The results are described. (M.O.W.)

15371 CHARACTERISTIC ENERGY LOSSES OF 8 keV ELECTRONS IN LIQUID In–Al AND In–Bi ALLOYS. Powell, C. J. (National Bureau of Standards, Washington, D. C.). Advan. Phys., 16: 203-13(Apr. 1967).

Measurements were made of the characteristic energy losses of 8-keV electrons in a series of liquid In–Al and In–Bi alloys, in order to avoid the confusing effects of phase mixtures present in most similar studies of solid alloy systems. Loss spectra were measured in a reflection-type scattering geometry with total electron-scattering angles of 15 and 70°. Two principal energy-loss peaks, identified as being due to surface plasmon and to volume plasmon excitation, were found to vary as a function of alloy composition in each system. Deviations from the variation expected from a simple free electron model could be interpreted in some cases in terms of an interband electronic transition occurring near the measured volume and surface energy-loss peaks. For bismuth-rich In–Bi alloys and for indium-rich In–Al alloys the transmission energy and oscillator strength could be estimated and shown as a function of composition. (auth) (UK)

15372 POSITRON ANNIHILATION IN SOLID AND LIQUID METALS. Kusmiss, J. H.; Stewart, A. T. (Univ. of North Carolina, Chapel Hill). Advan. Phys., 16: 471-7(July 1967).

The angular correlation of the gamma rays resulting from the annihilation of positrons in 15 solid and liquid metals and semiconductors was studied. Experiments were made on each material at room temperature and at temperatures above and below the melting point. The elements investigated fall into three categories, according to the way the angular correlation distribution changes as the melting point is reached. To within the experimental angular resolution (0.5 milliradians) no change in the angular correlation distribution was observed for Li, Se, Na, and Tl upon heating from room temperature to beyond the melting point. The elements Sb, Bi, Ga, Hg, Sn, and Te exhibited changes in their angular correlation distributions only on melting, whereas for the metals Al, Cd, In, Pb, and Zn changes occurred when the specimen was heated from room temperature to temperatures below the melting point. Changes in the angular correlation distribution upon heating or melting are generally manifested as (a) a narrowing of the central part of the curve, (b) a rounding-off of the parts of the curve near the Fermi cut-off angle, and (c) a change in the area of the broad background curve as compared with the area under the central peak. (auth) (UK)

15373 METASTABLE ATOMS AND MOLECULES. Muschlitz, E. E. Jr. (Univ. of Florida, Gainesville). Science, 159: 599-604(Feb. 9, 1968).

A review is presented of some of the properties of metastable excited states. The differences between the ground state and the metastable states are pointed out, and some of the factors affecting lifetime are discussed. The effects of the excitation on interactions between two atoms or molecules and the use of molecular-beam techniques to study intermolecular forces are considered. The processes of elastic and inelastic collisions are discussed in detail, and some data are presented on rare gases and other atoms. Mechanisms of Penning ionization are discussed. (D.L.C.)

15374 RADIATION SCATTERING DATA ON LIQUID METALS. Egelstaff, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Advan. Phys., 16: 147-69(Apr. 1967).

The scattering of radiation by liquid metals provides data on both the microscopic and the macroscopic properties of the metal. The macroscopic properties are obtained as a limit in which the momentum transferred by the radiation to the liquid is vanishingly small, while the microscopic structure and dynamical behavior are obtained from data at higher momenta. An outline of the theory of radiation scattering is given, which emphasizes the relation between neutron and x-ray results. The possibility of studying electron shell movements by measuring the ratio of x-ray to neutron intensities is discussed. In general there are two types of experiment: those in which the intensity is measured as a function of the momentum transfer only (S(Q)), and those in which the intensity is measured as a function of both energy and momentum transfer ($S(Q,\omega)$). The former experiments are used to obtain information on atomic positions, while the latter experiments (coupled with the former) are used to derive dynamical information. Both kinds of experiment are discussed, and some methods of interpreting (S(Q)) and $S(Q,\omega)$ are described. The cooperative modes of motion in the system, particularly for wavelengths of the order of the spacing between atoms, may be observed as peaks in $S(Q,\omega)$. Several recent experiments of this kind on liquid lead are discussed, particularly those in which the temperature variation was studied. In addition, information on the velocity correlation function for the metal atoms may be obtained. The spectral density of the velocity correlation is considered and compared to predictions based on the cooperative mode picture. It is concluded that while much information has been obtained from these experiments there is more detailed and extensive work to be done with both neutrons and x rays. (auth) (UK)

15375 MOLECULAR BEAMS AND A CHEMICAL REACTION. Greene, E. F. (Brown Univ., Providence); Ross, J. Science, 159: 587-95(Feb. 9, 1968).

Progress in molecular beam reactions is illustrated using the reaction of potassium atoms with methyl iodide molecules. The distribution of energy in the reactants is discussed, and results of molecular beam experiments are described. Some theoretical work (classical trajectories) are compared with the experimental results. The quantities now known in detail include total cross sections, interaction potential, threshold energy, distance, impact parameter, reaction probability, reaction cross section, and energy partition. (D.L.C.)

15376 MECHANISM OF RADIATION GENERATION IN CADMIUM SULFIDE BY ELECTRON BEAM EXCITATION. Bogdankevich, O. V.; Devyatkov, A. G.; Orlov, V. S. (Inst. of Physics, Moscow). Fiz. Tekh. Poluprov., 1: 638-45(1967). (In Russian).

An investigation was made of various characteristics of spon-

taneous and stimulated emission in CdS single crystals excited by an electron beam. Rectangle 0.5 × 1 × 2 mm parallelepipeds were cut from CdS single crystals. The opposite faces formed a resonator used for the generation of stimulated emission, which appeared at a high excitation level. The crystals were strengthened on the copper heatsink of a helium cryostat. The investigations were conducted in a temperature range from 30 to 300°K. The luminescence excitation of the specimens was accomplished by a pulsed beam of fast electrons with energies of 50 and 200 keV. The pulse duration was 0.2 μsec for 50 keV and 2.5 μsec for 200 keV; the sequence frequency was 50 cps. The density of the beam current for an energy of 200 keV was up to 1 A/cm² and for 50 keV, up to 6 A/cm². A comparison of results obtained from the excitation of radiative CdS recombination with a beam of fast electrons with results from optical excitation showed that the general character of the spectra and dependences obtained by using different excitation methods were similar. The reasons for the similarity are that (1) the multiplication time as a result of avalanche ionization, the multiplication time of nonequilibrium carriers, and the relaxation times of pulses and energy carriers appear to be considerably smaller than their lifetimes in excited states, and (2) the heating of an electron-hole gas by an intensive beam is unimportant and cannot prevent population inversion in cadmium sulfide. It is concluded that the generation of coherent radiation in CdS occurs on transitions corresponding to the annihilation of the exciton captured by the neutral acceptor, along with the emission of different acoustic phonons. (ATD)

15377 KEPLER'S EQUATION, FOCK VARIABLES, BACRY'S GENERATORS AND DIRAC BRACKETS. Gyorgyi, G. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 53A: 717-36(Feb. 1, 1968).

A formulation of the Kepler problem, manifestly invariant with respect to the SO_4 and $SO_{3,1}$ groups, respectively, is given in terms of the Fock variables and their canonical conjugates; one is led to introduce a new time parameter, proportional to the eccentric anomaly. A transformation of the dynamical variables performed in order to get back the standard time t leads in a natural way to Bacry's generators. A manifestly $SO_{4,2}$ symmetric formulation of the problem is given. The concept of the Dirac bracket is used to establish a connection with the usual three-dimensional description. (auth)

15378 SEMI-EMPIRICAL CALCULATION OF POLARIZATION IN ATOMIC COMPUTATIONS. Gurchumeliya, A. D. Tr. Gruz. Politekh. Inst., No. 2, 13-20(1966). (In Russian).

The semi-empirical method is used to investigate the polarization effects in the following systems: atomic core + external electron (bound state) and atom + bombarding electron (continuous spectrum). The polarization correction to the energy equations of the external electron is computed according to perturbation theory with Slater functions for the 0 approximation. The Bates polarization potential is used with an indefinite adjustable parameter. Results of computations for external electrons in the Li and Na atoms are presented. The case where the energies of the bombarding electron are small is considered for the continuous spectrum. The analytical approximation of the Hartree potential is used. The Cohn variational method is used to determine the scattering length of zero energy electron produced by the N atom and the corresponding value of the effective cross section. (ATD)

15379 SPIN DEPENDENT ATOMIC REACTIONS IN A HELIUM DISCHARGE AND EXTRACTION OF A $^3He^+$ ION BEAM FROM AN OPTICALLY POLARIZED ^3He SOURCE GAS. Stockwell, Norman David. Houston, Texas, Rice Univ., 1967. 105p.

Thesis.

The collisional mixing of the excited 2^3P levels of He is investigated by experiments using the optical pumping of ^4He. The isotope shift in a ^3He lamp allows an experimental test of the theory of ^4He optical pumping developed here. The theory predicts a reversal in the sign of the optical signal as mixing conditions vary. This reversal is observed and the theory gives the cross section for mixing among the 2^3P levels as 10×10^{-16} cm² $\leq \sigma_{mix} \leq 44 \times 10^{-16}$ cm². The upper limit is about 20% smaller than the value recently measured by resonance fluorescence techniques. In a pulsed He discharge, the metastable-metastable reaction $He(2^3S_1) + He(2^3S_1) \rightarrow He^+ + He(1^1S_0) + e^-$ provides the major source of electrons in the afterglow. Electron densities are measured by the technique of observing the shift in resonant frequency of a cylindrical cavity (TE_{011} mode, 10^{10}Hz) surrounding the discharge. According to the Wigner spin rule this reaction is expected to conserve electronic spin. Therefore, when the metastable sublevel populations are appropriately modified by optical pumping, changes in electron density during the afterglow are expected. The changes observed represent a direct experimental test of the conservation of electron spin in 2S states of He. The results indicate that spin is conserved in at least 20 to 30% of such collisions. Other electron production processes probably make this result artificially low. Electron densities in discharges typically used in ^3He optical pumping are found to range between approximately 2×10^8 e^-/cm³ and 2×10^9 e^-/cm³. A $^3He^+$ ion beam of ~0.6 μA has been extracted from a source gas of ^3He with polarization, $P_0 \simeq 3\%$. Theory indicates the beam polarization should be between P_0 and $P_0/2$. The source is designed to give a 300-keV beam which will be used to test beam polarization through the $^3D(^3He,^1P)^4He$ reaction. The polarization of the protons scattered at 90° is related to the beam polarization and will be measured. Using well understood techniques P_0 should be increased significantly from 3%. (Disser. Abstr.)

15380 THE ATOMIC DEBATES, BRODIE AND THE REJECTION OF THE ATOMIC THEORY, THREE STUDIES. Brock, W. H. (ed.). Leicester, Eng., Leicester University Press, 1967. 194p. 35s.

The three studies in this book seek to provide a detailed account of one chemist's serious alternative to atomism in the form of an operationalism which preceded and anticipated Bridgman's use of the term by sixty years. The first study examines the various traditions which led chemists to reject the atomic theory. The other two essays provide a complete analysis of Brodie's "Calculus of Chemical Operations," together with the publication for the first time of a selection from his correspondence with Williamson, Odling, Jevons, DeMorgan, and others on this subject. (W.D.M.)

Cosmic Radiation

Refer also to abstracts 14790, 15273, 15308, 15315, 15441, 15474, 15663, 15671, 15672, 15704, 15712, and 15964.

15381 (D-1-82-0625) TRANSPORT OF COSMIC RAYS IN THE INTERPLANETARY MEDIUM. Roelof, E. C. (Boeing Scientific Research Labs., Seattle, Wash. Geoastrophysics Lab.). Oct. 1967. 10p. (CONF-670628-8). Dep. CFSTI.

From 10th International Conference on Cosmic Rays, Calgary, Alberta, Canada.

By quasi linearization of the Liouville equation for a charged particle in an electromagnetic field combined with an ensemble average over field configurations, a transport equation is derived for the ensemble average particle-distribution function. The resulting integro-differential equation is rewritten in terms of a simpler characteristic function which, when found, gives the complete solution in terms of the particle orbits in the ensemble mean fields. With the appropriate approximations, the equation reduces to the Fokker-Planck form applied recently by Jokipii to galactic cosmic-ray modulation, and by the author to energetic solar-flare particle propagation. It is argued that the equation, although complicated, offers several advantages as a starting point for transport theory over the simpler but less appropriate Fokker-Planck and Boltzmann equations. (auth)

15382 (ORNL-TM-2100) AN ESTIMATE OF THE PROMPT PHOTON SPECTRUM ARISING FROM COSMIC-RAY BOMBARDMENT OF THE MOON. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Jan. 4, 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

An estimate was made of the photon leakage spectrum from the Moon due to photons arising from the capture and inelastic scattering of neutrons produced by galactic cosmic rays. The method of calculation consisted of estimating the energy and spatial distribution of the neutron flux in the Moon and then using Monte Carlo methods to obtain the photon source and to perform the photon transport. While the photon production and transport are carried out with some exactitude, the results must be considered very approximate because of the approximate neutron-flux distribution that is used. In particular, no attempt is made to account for the important effect which hydrogen in the lunar composition would have on the neutron-flux distribution. (auth)

15383 COSMIC-RAY STARS IN PHOTOGRAPHIC EMULSION AT HIGH ALTITUDE. Ganguly, S. R.; Mondal, S. K.; Chatterjee, S. D. (Jadavpur Univ., Calcutta). Indian J. Phys., 41: 471-81 (July 1967).

Ilford G_5 photographic plates were sent in jet planes to an altitude of 7100 m and stars formed in the emulsion were investigated. 70.5% of the stars are found to be produced by neutrons; the size distribution of stars formed by charged and neutral primaries are represented in two histograms. The ratio of α particles to protons released in a star is studied as a function of star size and this ratio is found to be constant at 0.43 for stars with 8 or more prongs. Energy distribution of α particles from stars, as well as the variation of the number of grey particles with star size, are

presented graphically; mean energy of α particles is found to be 13.4 MeV and the number of grey tracks is seen to increase linearly with star size. The size number distribution of all stars was studied and this seems to be represented by two straight lines: $N(>n) = A \exp(-0.341n)$ for $n \leq 6$, and $N(>n) = B \exp(-0.256n)$ for $n > 6$. The distribution curve is compared with those obtained by other workers at 3460 and 21,000 m, respectively, and a steepening of slope with decrease of altitude is noted. A method of obtaining energy spectrum from the size distribution is indicated. (auth)

15384 ACCELERATING MECHANISMS AND ORIGIN OF COSMIC RAYS. Schatzman, E. (Institut d'Astrophysique, Paris). pp 227-87 of High Energy Astrophysics. Vol. II. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

Several processes can produce fast particles such as primary cosmic rays, solar cosmic rays, stellar cosmic rays, and extragalactic cosmic rays. These processes are briefly reviewed and the problems of accelerating from thermal to superthermal energies and the proper physical conditions under which the acceleration can actually take place are considered. Topics covered include accelerating mechanisms, motion of charged particles and Fermi mechanism, stochastic mechanisms, random Liouville equation, and acceleration by radiation. (W.D. M.)

15385 ORIGIN OF COSMIC RAYS. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). pp 289-326 of High Energy Astrophysics. Vol. II. DeWitt, C.; Schatzman, E.; Veron, P. (eds.). New York, Gordon and Breach, Science Publishers, 1967.

The following phenomena are studied: solar events (which are related to cosmic rays in the solar system and on the Earth), galactic cosmic rays at the Earth, cosmic rays in the Galaxy and in the envelopes of galactic supernovae, in other normal galaxies, radio galaxies, and quasars. (W.D.M.)

15386 ENERGY SPECTRUM OF FAST COSMIC-RAY NEUTRONS NEAR SEA LEVEL. Gold, Raymond (Argonne National Lab., Ill.). Phys. Rev., 165: 1406-11(Jan. 25, 1968).

Measurement of the sea-level spectrum of cosmic-ray neutrons in the energy region 0.05 to 2.0 MeV was carried out with 4π hydrogen-recoil proportional counters. Electronic pulse-shape discrimination was utilized to reject meson- and photon-induced events. In general, the flux per unit energy decreases monotonically with increasing energy. The experimental data reveal some structure which may be due to scattering resonances in elements that dominate the environment. An integral flux of 2.3×10^{-3} neutrons/cm^2 sec in the interval 0.05 to 2.0 MeV was obtained for the air–land interface at the Argonne National Laboratory site (53°N geomagnetic latitude). (Phys. Rev.)

Direct Energy Conversion

15387 (AERE-M-1768) THERMOELECTRICITY: A STATUS SURVEY. Hare, G. E. (Atomic Energy Research Establishment, Harwell (England)). July 1966. 16p. Dep. CFSTI. UK.

In recent years thermoelectricity has developed from a convenient method of temperature indication to being the basis of new systems for power generation and heat pumping. It seems likely that in the near future many people will be considering the potential of these new devices in their own fields, and since they will probably be unfamiliar with the technology involved, an attempt is made to provide a quick introduction covering the physical phenomena, simple design procedures, and the present "state of the art." Thermomagnetic phenomena such as the Nernst, Ettinghausen, and Reghi-Leduc effects are not considered, but there is some mention of the recent work on the enhancement of thermoelectric properties in the presence of magnetic fields. (auth) (UK)

15388 SOME VOLT-AMPERE CHARACTERISTICS OF ARC-MODE THERMIONIC ENERGY CONVERTERS. Dyuzhev, G. A.; Martsinovskii, A. M.; Pikus, G. E.; Sonin, E. B.; Yur'ev, V. G. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 37: 1825-39(Oct. 1967). (In Russian).

Direct measurements have shown that the vertical branch of the characteristic is closely related to cord-discharge. The cord develops when a continuous conversion into the arc mode is impossible, i.e., when the temperature of electrons near the cathode in a diffusion regime is not sufficient to bring about an efficient ionization. It is shown that, for emission current densities $J \lesssim 10$ A/cm^2, a field develops near the cathode which retards the emission; in other words, a virtual cathode evolves. In such a case, two breaks can be seen in the characteristic, the upper one indicating total emission current of the plate and the lower one the filling of the gap with the discharge. If the current increase is attributed entirely to the anomalous Schottky effect, the anomaly factor $\beta \approx 6:7$ for $T_c = 1530$°K and $P_{C_s} = 0.44$ and 1.00 mm Hg, where T_c is the temperature of the cathode and P_{C_s} is the pressure in the reservoir. (TSS) (ATD)

15389 SOME DATA OBTAINED WITH AN EXPERIMENTAL MHD POWER PLANT. Kirillin, V. A.; Sheindlin, A. E. (Inst. of High Temperatures, Moscow). Advan. Energy Convers., 7: 247-56(Feb. 1968).

A brief account is given of a large experimental complex MHD power plant for open-cycle operation with combustion products of natural gas. The main distinguishing feature of such a plant in comparison with existing plants consists in the fact that with its help it is possible to investigate not only the MHD generator itself, but also other complicated components of MHD power plants. Another distinguishing feature of the described plant lies in the fact that it is intended for long-period service. Main parameters of the plant are given and the technological scheme is described, together with the combustion chamber, the MHD channel, the magnet system, facilities for injection and recovery of ionizing seeding, high-temperature air preheaters, end heat-exchanger systems, current-inverting systems, etc. A summary of experimental results is included. The MHD-generator output power amounted to 30 kW. Results of thermal and gasdynamic investigations carried out in the MHD channel agreed satisfactorily with theoretical calculations made on a refined one-dimensional flow model. Conditions were obtained not only for further wide-scale magnetohydrodynamic thermophysical and electrophysical investigations of MHD power plants but also for continuation of the work of investigating simultaneous operation of the MHD generator with other components of the plant, as well as for developing more rational designs of components and conditions for their operation. (auth) (UK)

15390 EFFECTIVE CONDUCTIVITY IN A SEGMENTED-ELECTRODE MAGNETOHYDRODYNAMIC GENERATOR WITH ELEVATED ELECTRON TEMPERATURE. Guha, S.; Singh, Y. P. (Indian Inst. of Tech., New Delhi). Brit. J. Appl. Phys., 18: 1819-20(Dec. 1967).

The effective conductivity in a segmented-electrode magnetohydrodynamic generator under typical operating conditions was calculated, using the power law for the dependence of electron collision frequency on electron velocity and expressions derived by M. S. Sodha (Brit. J. Appl. Phys., 16: 319-22(1965)). (auth) (UK)

15391 SYNCHRONOUS MAGNETOGASDYNAMIC INDUCTION GENERATOR OF MODULATED CONDUCTIVITY. Milewski, Jerzy. Pr. Inst. Masz. Przeply., No. 28, 3-36(1966). (In Polish).

The properties of a synchronous magnetogasdynamic generator with modulated conductivity of the working medium are analyzed. The study is confined to effects related to the generator's operation principle, while problems concerning the production and stability of the flow of the working medium are not discussed. A simplified system of magnetogasdynamic equations is presented in the first part of the analysis; the working medium is mostly treated as an ideal gas having conductance. A method to determine electric and gasdynamic characteristics of the generator as a whole, as well as of its individual sections, is established and given in the second part. Local electric characteristics (dependence of output power, electric efficiency, and other values related to generator sections in the main design and operational parameters) are determined. Effects of second-order factors upon power and efficiency of the sections are investigated. The third part contains formulas which (a) make it possible to determine the generator's collective electric characteristics from its local characteristics, and (b) relate the generator's local and overall operational parameters. The theorectical possibility was established of attaining full compensation of the core reluctance effect, while a reactive power appears simultaneously beside the generator's active power. Design of a generator having excessive core reluctance (or a too-low conductance of the working medium in relation to the core) would fall short of purpose, since in an operational generator, reactive power should be, at most, of the same order as active power. Part four deals with the flow dynamics of the working medium through the duct, assuming the medium to be an ideal gas. The basic gasdynamic characteristics are determined for generators (a) with duct having constant cross-section area, (b) with constant Mach number, and (c) with constant velocity. (ATD)

15392 HEAT BALANCE OF AN INDUCTION MHD GENERATOR WITH CONTINUOUS THROUGHFLOW. Lego, Jindrich (Czech Inst. of Tech., Prague). Elektrotech. Obz., 55: 372-5 (July 1966). (In Czech).

The heat balance of an ideally heat-insulated induction MHD generator with continuous plasma throughflow is set up. Relations

were found for the maximum generated output and the maximum pressure drop across the generator, and the conditions under which those extreme states arise were ascertained. In addition, relations were established for the electrical, turbine and Carnot efficiency, and these are discussed. (ATD)

15393 IMPROVEMENTS IN OR RELATING TO AIR PREHEATERS. Harrowell, Raymond Vivian (to Central Electricity Generating Board). British Patent 1,100,036. Filed July 20, 1965.

This preheater for preheating pressurized air comprises a recuperative heat exchanger having a plurality of ceramic tubes each formed in lengths with abutting flanges on the adjacent ends of two lengths, an independent combustion system for producing hot combustion gases at atmospheric pressure, a source of pressurized air and means for passing the combustion gases through the tubes and for passing the pressurized air around the outside of the tubes to be heated by the combustion gases passing through the tubes. With this construction, the air to be heated is passed through the heat exchanger at a higher pressure than the heating gases in the tubes of the heat exchanger. With a ceramic tube heat exchanger, there is very great difficulty in making gas-tight joints between lengths of ceramic tubes and between the tubes and end plates. With the arrangement of the present invention, the sealing between lengths of tube is obtained by the provision of the abutting flanges on the adjacent ends of two lengths of tube. The joints in such a construction are made by the difference in pressure between the air on the outside of the flanges and the gas in the gap between the flanges, in the same way as a suction pad is held onto a wall. The abutting flanges of the ceramic tubes may be coated with a viscous material, such as glass or quartz, in order to tighten the sealing. Very conveniently, the heat exchanger is arranged with the tubes having their axes upright. The tubes may be made of alumina and each tube through the heat exchanger may be made in a number of separate sections. (TSS)

15394 IMPROVEMENTS IN AND RELATING TO THERMOELECTRONIC ENERGY CONVERTERS FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). British Patent 1,102,549. Feb. 7, 1968. Priority date June 9, 1964, France.

There was described in British Patent Specification No. 1,065,978 a thermoelectronic energy converter comprising elementary nuclear fuel bars, an elementary anode surrounding coaxially each nuclear bar, the elementary anodes being connected to each other by connecting rings to form a tubular electrode on which said nuclear bars are mounted, the connecting rings consisting of annular portions having an electrical resistance greater than that of the elementary anodes. For this purpose, these connecting rings are composed of alloys or pure metal having a sufficiently high electric resistivity and moreover, these alloys or metals are employed rather thin so that the electrical resistance of the rings is high enough to reduce the current flowing therethrough to a low value, for example, at the most equal to $1/10$ of the total current. The object of this addition is to improve this device by increasing the resistance of the connecting rings between the elementary anodes while employing therefor metals having resistivities and thicknesses of conventional type. (TSS)

15395 MAGNETOHYDRODYNAMIC GENERATORS. (to Siemens-Schuckertwerke Aktiengessellschaft). British Patent 1,102,040. Feb. 7, 1968. Priority date Aug. 27, 1964, Germany.

The generator described here consists of: a first annular magnetic coil; a second annular magnetic field coil located within the first coil, the axis of which coincides substantially with or is substantially parallel to that of the first coil; and a generation channel which extends in a radical gap between the two coils around the said axis, so that the plasma flow path within the channel is at least approximately ring shaped. The arrangement is such that when the generator is operated with the coils carrying currents which tend to produce oppositely directed axial magnetic fields, the magnetic forces between the two coils, due to the flow of said current in the coils, is then in equilibrium, the operational magnetic field for the generation channel being then provided by the resultant magnetic field of the two coils. The two coils are superconducting, each comprising an exciter winding and a supporting ring with cooling channels, which in turn are connected to pressure equalizing vessels. The generation channel is funnel-shaped in that its cross section increases in the operational direction of flow of plasma therein. (TSS)

15396 THERMIONIC GENERATOR. Gabor, Dennis; Nilson, John Anthony (to National Research Development Corp.). British Patent 1,101,748. Jan. 31, 1968. Filed May 12, 1964.

The generator described has two electrodes (heater and collector) contained in a vacuum-tight envelope containing gases such as argon, krypton, or xenon at a pressure of the order 0.1 to 5.0 torr, or mixtures of these gases with metal vapors. The collector electrode may preferably comprise part of the vacuum envelope and may be immersed in a coolant. The collector electrode carries auxiliary anodes insulated from it by means of beads of a suitable insulator such as an enamel. Wires are centered in the bores of the auxiliary anodes by means of beads or tubes of ceramic material, the wires themselves consisting preferably of refractory materials. The total area of the auxiliary anodes is less than one-thousandth that of the emitter. (TSS)

Fluid Physics

15397 NUMERICAL STUDY OF TWO FLUID RAYLEIGH–TAYLOR INSTABILITY. Daly, Bart J. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Fluids, 10: 297-307(Feb. 1967). (LA-DC-8254).

A new computing technique for the time-dependent calculation of the interaction of two incompressible fluids is used to study the linear and nonlinear phases of Rayleigh–Taylor instability. The variation of the linear growth rate with Reynolds number is examined for Reynolds numbers <200 at a ratio of fluid densities of 2:1. These findings support Chandrasekhar's predictions of the magnitude of the growth rate and the Reynolds number for which maximum growth rate is attained. A series of inviscid flow calculations, at density ratios between 1.1:1 and 10:1, is used to explore the effect of density ratio on aspects of the nonlinear Rayleigh–Taylor instability. It is found that such influences as form drag and Kelvin–Helmholtz instability decrease rapidly in importance as the density ratio increases. (auth)

15398 HYDROMAGNETIC STABILITY OF A LIQUID FILM FLOWING DOWN AN INCLINED CONDUCTING PLANE. Gupta, A. S.; Rai, Lajpat (Indian Inst. of Tech., Kharagpur). J. Phys. Soc. Jap., 24: 626-32(Mar. 1968).

The stability analysis is presented for a film of a viscous, electrically conducting liquid flowing down an inclined plane in the presence of a magnetic field applied perpendicular to the plane which is also electrically conducting. The resulting Orr–Sommerfeld equation is solved by a regular perturbation technique for disturbances of wavelengths large compared with the thickness of the film. Conductivity of the plane is found to delay the onset of instability. (auth)

15399 STAGNATION-POINT FLOW IN MAGNETOHYDRODYNAMICS. Boger, R. C.; Ludford, G. S. S. (Army Research Office, Durham, N. C.). Z. Angew. Math. Mech., 47: 449-64 (Nov. 1967).

The inviscid three-dimensional stagnation point in magnetohydrodynamics is investigated in full generality. The analytic character of the flow depends on two parameters, one of which characterizes the streamline pattern on the body and the other the effective interaction of the electromagnetic field. The pattern, according to linear terms, must be either nodal or contain a stagnation line; the spiral and saddle-point patterns are ruled out. A method of obtaining the flow to arbitrary accuracy is presented; improvement is regressive, i.e., from higher- to lower-degree terms. With higher-degree terms the stagnation line in general gives way to a combination saddle–nodal point, which has not been noticed before. (auth)

15400 MAGNETOACOUSTIC ATTENUATION IN LIQUID GALLIUM TO 150 kG. Shapira, Y. (Massachusetts Inst. of Tech., Cambridge). J. Acoust. Soc. Amer., 41: 584-6(Mar. 1967).

The Anderson theory (ibid., 25: 529(1953)) for the effects of a magnetic field on ultrasonic propagation in liquid metals, which is based on magnetohydrodynamic considerations, predicts that the ultrasonic attenuation and velocity increase quadratically with the magnetic-field intensity $\underline{H}$. Investigation of magnetoacoustic attenuation in liquid Ga showed that this theory serves as a basis for understanding magnetoacoustic phenomena in liquid metals, solid metals with short electron mean free path, and high-field superconductors. The attenuation of 8.5-, 24-, and 56-Mc sound waves in liquid Ga was measured in steady magnetic fields up to 146 kG. The magnetic field was always perpendicular to the direction of sound propagation. The results showed good reproducibility of the data from run to run but some scatter at high fields. To facilitate a comparison between theory and experiment, the predictions of the theory were plotted. These curves were calculated using the measured sound velocity 2.76×10^5 cm/sec, the density 6.09 g/cm^3, and the electric resistivity 26 $\mu\Omega$-cm. There was good over-all agreement between theory and experiment. The data points for the 24- and 56-Mc sound waves straddled the theoretical curves more or less symmetrically. In the case of the 8.5-Mc waves, however, the data points at high fields lay slightly above the theoretical curve. (BBB)

15401 MAGNETOHYDRODYNAMIC EXPERIMENTS USING TRANSPARENT ELECTROLYTES. Conn, C. R. (Educational Services, Inc., Newtown, Mass.); Heiser, W. H. Bull. Mech. Eng. Educ., 6: 85-8(Jan.-Mar. 1967).

Several experiments were performed to illustrate the fact that magnetohydrodynamic (MHD) body forces can be either rotational or irrotational. The use of a transparent electrolyte as the working fluid allowed visualization of the effects of such body forces on flow patterns. It is pointed out that the $j \times B$ (j = supplied current density, B = ambient magnetic field intensity) electromagnetic body forces can affect the streamline pattern and pressure distribution of the flow of a conducting fluid without the necessity of inserting foreign objects directly into the flow. MHD forces can be directly under the control of the experimenter. Their effects on flow patterns can be made visible by means of dye injection in flowing transparent electrolytes. The demonstrations described were chosen to illustrate the differences between the behavior of fluids under the action of rotational and irrotational MHD forces. (BBB)

15402 IONIZED GAS FLOW PAST A CYLINDER AND A SPHERE. Pietrzyk, Z. A.; Rudowska, T. T. Arch. Mech. Stosow., 19: 231-41(1967).

Some observations were made on ionized air flow past cylinders and spheres under various conditions. The flow-producing device was an electromagnetic shock tube with concentric electrodes. The observations were made under quasi-steady flow conditions downstream from the shock wave. The zone light upstream of the body coincided, for a perfect gas, with the displaced shock wave near the stagnation point. At some distance from the stagnation point, the zone light did not coincide with the shock wave for a perfect gas and probably did not coincide with the shock wave formed upstream from the body. No relation was detected between the displacement of the zone light upstream from the body and the Reynolds number. The least measured distance of the zone light was comparable with the free path of particles of a perfect gas; therefore, the interaction between ions and electrons plays an essential role in the transmission of information between particles of an ionized gas. With such an interaction, the free path is by 5 orders of magnitude smaller than for a perfect gas. The temperature distribution over the surface of a model did not show geometric similarity. (BBB)

15403 DEFORMATION OF A VELOCITY PROFILE IN AN INHOMOGENEOUS MAGNETIC FIELD. Vatazhin, A. B. Prikl. Mat. Mekh., 31: 72-9(1967). (In Russian).

The flow of an incompressible, inviscid, conducting fluid is analyzed in a plane channel (in the presence of an inhomogeneous magnetic field). The various flow parameters are expanded in powers of the magnetic interaction number. The magnetic field is assumed to be inhomogeneous. It is shown that for an increased value of the Hall parameter the symmetric velocity profile is displaced towards the wall. For a uniformly conducting fluid with insulated walls the pressure drop is obtained for a nonzero wall velocity with the unperturbed profile. It is shown that increasing the wall velocity tends to decrease the velocity perturbations in the channel. (TSS) (ATD)

15404 CONCERNING THE ROTATION OF AN ELECTRICALLY CONDUCTING LIQUID. Stan, I.; Pop, I. Bul. Inst. Politeh. Iasi, 12: 117-20(1966).

The motion in a conductive liquid inside a cylinder rotating about its axis of symmetry placed in a radial magnetic and an axial electric field is considered. (Rom. Sci. Abstr.)

15405 STEADY-STATE FLOW OF A LIQUID METAL IN A MAGNETOHYDRODYNAMIC CHANNEL OF RECTANGULAR CROSS SECTION. Khozhainoi, A. I. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 114-17(1966). (In Russian).

The results of an investigation of the effect of a transverse magnetic field on the coefficient of resistance in the flow of mercury in a magnetohydrodynamic channel with a wall ratio of 1 : 2.5 are reported. The experimental magnetohydrodynamic channel was included in a closed circulating system, with distilled mercury. The mercury was set into movement by a mechanical pump, and the flow rate could be regulated within wide limits. The flow rate was recorded with an electromagnetic flowmeter. The pressure in the channel was measured with two-liquid mercury-distilled water manometers. A diagram of the system is shown. The investigations were carried at values of the Hartmann number equal to 6.75, 14.3, 20.5, 27.2, 40.0, and 61.0 in a range of change of the Reynolds number from 1600 to 32,000. A figure shows a plot of the experimental results in the form of the dependence of log ($100\ \lambda_{tm}$) on log R. The results indicate that the transition from laminar to turbulent flow in the case under consideration is observed at $\lambda \approx 0.0177$ = const. (ATD)

15406 SOME INVESTIGATIONS ON INVISCID BOUNDARY LAYER OF MAGNETOHYDRODYNAMICS. Inouye, Kenji (National Aerospace Lab., Tokyo). J. Phys. Soc. Jap., 24: 412-21 (Feb. 1968).

The inviscid boundary layer in a two-dimensional aligned-field flow of highly conducting, inviscid, incompressible fluid is considered. If a transformation analogous to one in conventional viscous boundary layer problem is applied, a general solution of the magnetic boundary layer in the case of very weak magnetic field is obtained. A similar solution for the stagnation point flow is obtained by the method of series expansion in pressure number. The solution for the same flow is also obtained by integrating directly the original equations without any expansion. Both solutions are compared with each other. The discussions on the thickness of the boundary layer and nonexistence of the solution for the case of the pressure number greater than unity are given. (auth)

15407 FLUTTER OF A CYLINDRICAL SHELL IN A FLOW OF A COMPRESSIBLE CONDUCTIVE FLUID IN PRESENCE OF A MAGNETIC FIELD. Bagdasaryan, G. E.; Belubekyan, M. V. (Inst. of Mathematics and Mechanics, Erevan). Inzh. Zh., Mekh. Tverd. Tela, No. 6, 50-6(1966). (In Russian).

The dynamic stability of an infinite circular cylindrical shell is investigated in an outer longitudinal supersonic flow of a perfectly conducting inviscid gas with a certain undisturbed velocity at infinity. Inside the shell the gas is at rest under pressure equal to that of the undisturbed gas flow. There is an outer magnetic field parallel to the shell axis. The investigation is carried out assuming the validity of the following assumptions: (1) Kirchhoff–Love hypothesis on nondeformable normals; (2) conventional simplifications in the theory of shells with a large index of variation; (3) disregard of the electromagnetic effects in the shell; (4) equality to unity of the magnetic and dielectric permeabilities of the gas and of the shell material; (5) correctness of the Maxwell equations for the vacuum in the inner space of the shell. The following initial equations and relationships are used in accordance with these assumptions: (a) the equations of magnetogasdynamics for the outer space of the shell; (b) the equation of the shell motion; (c) an expression for the normal component of the outer surface load; and (d) the equations of the magnetic and electric fields in the vacuum. Equations (a) and (d) are linearized on the assumption that the disturbances are small, and linearized equations (e) are obtained which describe the states in the outer and inner spaces of the shell and satisfy the boundary conditions on both surfaces of the vibrating shell. A characteristic equation is obtained (by a simultaneous solution of equations (a) to (e)) from which the natural frequency w and the divergence speed U (by putting $w = 0$) of the shell can be determined. The effects of Mach and Alfvén numbers, of the rate of elastic wave propagation V, and of magnetic field intensity on U are mentioned. The condition of attaining the flutter speed M_f, as well as instability regions of the shell are discussed, and an expression for M_f in the case when $V < U$ is derived. (ATD)

15408 CHARACTERISTICS OF A FINITE LENGTH MHD TRAVELING WAVE CYLINDRICAL ACCELERATOR OR GENERATOR. Jester, Jerry Larkin. Morgantown, W. Va., West Virginia Univ., 1967. 168p.

Thesis.

The primary aim of this paper is to determine the characteristics of an electrodeless cylindrical traveling wave accelerator of finite length. Previous work in MHD power generation has shown, particularly for ac electrodeless generators, that a major portion of losses are due to fringing effects related to the small number of wavelengths of the device. From practical considerations, it is desirable to maintain a reasonably short length for the accelerator or generator; on the other hand, the efficiency of these devices is particularly sensitive to fringing effects associated with short lengths. This theoretical study determines quantitatively the electrical efficiency of an accelerator or generator of length comprising any integral or fractional number of wavelengths of the primary coil windings. In the second part of the paper a solution is presented which determines the correction coils necessary to eliminate first order fringing losses. (Disser. Abstr.)

Geophysics

15409 (LA-DC-9344) REVIEW AND INTERPRETATION OF PARTICLE MEASUREMENTS MADE BY THE VELA SATELLITES IN THE MAGNETOTAIL. Hones, Edward W. Jr. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 36p. Dep. CFSTI.

The Vela nuclear test detection satellites are in near-circular orbits around the Earth at a geocentric distance of about 17 R_E. This paper discusses data obtained from four of these satellites —

Vela 2A and 2B (launched in July 1964) and Vela 3A and 3B (launched in July 1965). The orbits of these four satellites lie in a plane inclined about 60° with respect to the ecliptic plane. The satellites spend roughly one third of their time in the magnetotail. (W.D.M.)

15410 (MIT-2241-35) ON THE DYNAMICS OF THE THERMOSPHERE. Report No. 20. Lagos, C. Pablo (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). Sept. 1, 1967. Contract AT(30-1)-2241. 141p. Dep. CFSTI.

A dynamically consistent set of simplifie ' equations applicable to large-scale motion in the thermosphere is rigorously developed from the Navier-Stokes equations. The simplifications are justified by means of a scale analysis. These equations form a basis of the dynamics of the thermosphere. Sources and sinks of energy are discussed and analytic solutions of the heat conduction equation are obtained, using a Green's function technique. The diurnal pattern of heating and the accompanying structural changes in the thermosphere is first studied in a numerical model depending only upon altitude and time. The energy sources are taken to be solar heating, radiation cooling, and conduction. No explicit account is taken of horizontal variation and horizontal motion in the model. Comparison of model structure with the observed structure of the thermosphere points to the existence of large-scale poleward transport of heat by horizontal motion in the thermosphere. The transport is required in middle and high latitudes at equinox and at all latitudes in the winter hemisphere near the solstice. When explicit account is taken of the horizontal variation and the equations of motion are included, a dynamical model of the thermosphere is obtained. The full set of equations are discussed. A two-dimensional model, allowing no latitudinal variation, is used to study the effect of horizontal motions on the phase and amplitude of the diurnal temperature oscillation. Under these conditions the computations indicate: (1) horizontal energy transport by advective processes cannot modify the phase of the diurnal temperature oscillation; (2) adiabatic heating and cooling by vertical motion provides a heat source in the thermosphere. With vertical motions included, the calculated maximum temperature shifts from about 1800 local time, as calculated from the one-dimensional model, to about 1400 local time, as is observed. (auth)

15411 (NP-17106) RADIATION AND HIGH ALTITUDE LABORATORY. Organization; Research Program; Academic Activities; Publications. (Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina)). May 1967. 50p. Dep.

A brief review is presented of the program of the Laboratorio de Radiaciones y Alta Atmósfera for basic research on low-energy nuclear physics and its application to studies in the upper atmosphere with space vehicles. The investigations of nuclear events in the upper atmosphere are carried out by means of payloads located in rockets produced at the Institute. Some of the studies briefly reported are: orbital-electron capture; internal bremsstrahlung; internal conversion; and x-ray spectroscopy in the upper atmosphere. (S.F.L.)

15412 (AD-655364) RADIATION BELTS OF THE EARTH. Vakulov, P. V.; Gorchakov, E. V.; Logachev, Yu. I. Translated from Kosmi. Luchi, No. 6, 1957-1959. 130p. (FTD-MT-65-417). CFSTI.

In the proposed work, investigations of radiation, carried out by groups at Moscow State University and the Physical Institute of the Academy of Sciences of the USSR, with the help of Soviet artificial earth satellites and space rockets launched in the IGY period during 1957-1959, are examined in detail. For the period, investigations of radiation were produced in two artificial satellites and in three space rockets. As a result, considerable experimental material has been accumulated which has nowhere been systematically published. An attempt is made to give a survey of results of these investigations, a detailed description of the equipment used, methods of transmission, and other questions connected with this. 69 references. (auth)

15413 CONFIGURATION AND RECONNECTION OF THE GEOMAGNETIC TAIL. Mihalov, J. D.; Colburn, D. S.; Currie, R. G.; Sonett, C. P. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 73: 943-59(Feb. 1, 1968).

A description of certain aspects of the geomagnetic tail is made using data from the Ames magnetometer on the Explorer 33 satellite. The general shape corresponds with earlier findings of Ness and co-workers. The tail is found regular to distances greater than 82 R_E. The field values for Kp $\leq$ 2+ vary from a low of about 4 gammas to a high value of 40 gammas. Generally the values are in the neighborhood of 10 to 20 gammas. A distinct skewing of the field lines away from the solar-antisolar direction is observed, such that an added component of magnetic field in the direction of planetary motion is present on both sides of the region of field reversal. The skewing appears to be greatest near the region of field reversal. Increase in field magnitude with increasing Kp is observed. The radial gradient can be shown to fit a power or exponential law with near equal validity. A correlation analysis of field magnetic with radial distance, ap, and transverse position coordinates, also is discussed. A radial gradient cannot be detected in the outermost half of the data (beyond 58 R_E), although significant correlation with geomagnetic activity remains. No significant cross gradient, apart from a radial gradient, is observed in the tail field. Strong evidence for reconnection of field lines is found, and statistics are presented for a dual mechanism regarding the residual Z field across the region of field reversal. The tail structure seems patchy at the neutral sheet, both near the magnetopause and near satellite apogee. (auth)

15414 CONTRACTION OF THE PLASMASPHERE DURING GEOMAGNETICALLY DISTURBED PERIODS. Taylor, H. A. Jr.; Brinton, H. C.; Pharo III, M. W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 961-8(Feb. 1, 1968).

Direct measurements of the thermal positive ions of hydrogen and helium have been obtained from positive ion mass spectrometers aboard the Orbiting Geophysical Observatories 1 and 3. Observations made during 1965 and 1966 show distributions of H^+ and He^+ extending to altitudes as great as 40,000 km, corresponding to a magnetospheric coordinate of L = 8. The outer boundary of the plasmasphere is characterized by an abrupt decrease in the ion concentration. This boundary or plasmapause, defined by the reduction of H^+ concentration to 5×10^0 ions/cm^3 or less, is often quite sharp, with decreases in ion concentration of as much as an order of magnitude occurring within 250 km. The position of the plasmapause is observed to move inward and outward from the Earth in an inverse correlation with the planetary magnetic activity index Kp, indicating significant large-scale expansion and contraction of the plasmasphere during periods of agitated magnetospheric conditions. The apparent correlation between measurements of the hydrogen ion boundary and the "knee" whistler evidence of the plasmapause suggests that the mechanism responsible for the depletion of the ionization is effective along the lines of the magnetic field, extending well into the Earth's inner atmosphere, to 1000 km and below. (auth)

15415 SOME AVERAGE PROPERTIES OF AURORAL ELECTRON PRECIPITATION AS DETERMINED FROM SATELLITE OBSERVATIONS. Sharp, R. D.; Johnson, R. G. (Lockheed Missile and Space Co., Palo Alto, Calif.). J. Geophys. Res., 73: 969-90(Feb. 1, 1968).

The total energy flux of electrons precipitating on the auroral zones was measured by particle detectors aboard a low-altitude, polar-orbiting satellite for the 5-day period from October 30 to November 4, 1963. The observations were made at local times of approximately 0100 and 1300 hours. Precipitating electrons were observed on almost every transit of the auroral zone. Parameters are defined characterizing the intensity, the angular distribution, and the energy distribution of the precipitating electrons. The relationships among these parameters and their dependence on Kp are examined. The averaged total precipitated energy flux was found to be approximately 5 times more intense on the night side than on the day side of the auroral zone, and the averaged energy distribution was found to be softer on the night side. The averaged angular distributions were found to be generally anisotropic, peaking at the higher pitch angles. The intensity of the precipitation was found to increase, the angular distribution became more isotropic, and the averaged spectral hardness increased as Kp increased. The averaged energy and angular distributions were also found to undergo significant changes that occurred on a global scale and persisted for many hours, thus indicating that large-scale, rather than local, processes were responsible for these changes. The total auroral-zone energy input is computed for the period of the experiment, and by comparison with published measurements for the average solar wind properties, an "efficiency" of the auroral mechanism is calculated. This efficiency varies approximately from 0.01% to 0.2% as Kp varies from 0 to 5. (auth)

15416 EXPERIMENTAL INVESTIGATION OF ELECTRIC FIELDS PARALLEL TO THE MAGNETIC FIELD IN THE AURORAL IONOSPHERE. Mende, S. B. (Rice Univ., Houston, Tex.). J. Geophys. Res., 73: 991-7(Feb. 1, 1968).

Photometric observations were made of barium ions artificially injected into the ionosphere in rocket experiments carried out at Kiruna, Sweden. The scale height was measured for both neutral and ionized components. It is shown that an electric field parallel to the magnetic field lines ($E_{||}$) can be detected if its strength exceeds a few tens of microvolts/meter. Two cloud releases are analyzed, and it was found that in each case, $E_{||}$ cannot be larger than 60 μV/m. The measurement was carried out at high latitude

in the auroral zone, although there was no visible aurora at the position of the barium cloud. The ion cloud in the last release experiment developed a filamentary structure parallel to the magnetic field lines showing field-aligned ionospheric nonuniformities. (auth)

15417 RAPID VARIATIONS OF AURORAL PARTICLE FLUXES. Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res., 73: 999-1011(Feb. 1, 1968).

Fast time resolution particle measurements on six French rockets flown into auroras at times near local midnight indicate that statistically significant intensity variations of electrons with energies from 65 to >400 keV on time scales as short as several milliseconds often occur. Similar fluctuations of proton intensity are nearly absent. Variations occurring only for electrons with energies near 65 keV as well as variations involving only electrons with E > 400 keV were observed. Detailed analyses of 75 examples of rapid intensity variations fail to reveal whether they are typically caused by spatial or temporal inhomogeneities. Since the first observation of a fluctuation occurs as often in the lowest energy channel as in the highest, there is no significant energy dispersion of arrival times of electrons at the rocket. Thus, if the variations are temporal, the source must be closer than about 1 R_E from the rocket. If the variations are spatial, the electron guiding center density must occasionally change by an order of magnitude over horizontal distances less than 20 meters. (auth)

15418 RADIAL DIFFUSION COEFFICIENT FOR ELECTRONS AT LOW L VALUES. Newkirk, L. L.; Walt, M. (Lockheed Research Lab., Palo Alto, Calif.). J. Geophys. Res., 73: 1013-17 (Feb. 1, 1968).

An empirical evaluation of the diffusion coefficient for trapped electrons diffusing across low L shells is obtained by adjusting the coefficient to account for the observed radial profile and the long-term decay rate of the trapped electron flux. The diffusion mechanism is not identified, but it is assumed that the adiabatic invariants μ and J are conserved. The average value of the coefficient for electrons >16 MeV energy is found to decrease monotonically from $\sim 4 \times 10^{-6}$ R_E^2/day at L = 1.16 to $\sim 2 \times 10^{-7}$ R_E^2/day at L = 1.20. (auth)

15419 LOW-ENERGY COLLISIONS BETWEEN $O^+(^4S)$ AND H(1s). Stebbings, R. F.; Rutherford, J. A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Geophys. Res., 73: 1035-8(Feb. 1, 1968).

The cross section for charge transfer between $O^+(^4S)$ and H(1s) was measured down to 0.6 eV in the center of mass coordinate system. Extrapolation of these data to lower energies is carried out, and the implication of the resulting large thermal energy cross section to the composition of the Earth's high atmosphere is discussed. (auth)

15420 A SPATIAL MODEL OF THE F-REGION IONOSPHERIC TRAVELING DISTURBANCE FOLLOWING A LOW-ALTITUDE NUCLEAR EXPLOSION. Albee, P. R.; Kanellakos, D. P. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 73: 1039-53(Feb. 1, 1968).

The foF2 fluctuations observed by means of vertical-incidence ionosondes at various Pacific Island stations following the low-altitude, megaton-range nuclear explosion on October 30, 1962, were analyzed. By accounting for the influence of the Earth's magnetic field on the response of the ionosphere to the passage of the neutral atmospheric gravity wave (AGW) disturbance, the properties of the neutral AGW disturbance were determined as a function of time after the explosion and distance from the explosion. It was found that the average period of the neutral AGW increases linearly with range, with an additive constant; this constant is related to the initial period of a virtual source located within the ionosphere above the point of the explosion (G_0). The amplitude of the neutral AGW varies as exp(–kr), where r is the range from the explosion. Isoionic contours of the $\Delta N/N$ fluctuations were computed. Four cases of the expanding ionospheric disturbance are given for 22, 44, 65, and 109 minutes after the explosion; these times correspond to the expansion of the leading edge of the neutral AGW to 1000, 2000, 3000, and 50000 km from the explosion. The Housatonic data agree well with the published theoretical papers on AGW's generated by impulsive, low-altitude sources. (auth)

15421 INTERPRETATION OF AURORAL HISS MEASURED ON OGO 2 AND AT BYRD STATION IN TERMS OF INCOHERENT CHERENKOV RADIATION. Jorgensen, T. Stockfleth (Stanford Univ., Calif.). J. Geophys. Res., 73: 1055-69(Feb. 1, 1968).

A wideband noise known as auroral hiss is observed at very low and low frequencies at ground-based stations and on satellites at high magnetic latitudes. Several attempts have been made to explain this noise as incoherent Cherenkov radiation from energetic particles in the magnetosphere, but the conclusions were all negative, as the calculated power was several orders of magnitude below the observed power. The results of recent observations of auroral hiss and of the low-energy electrons with which this noise is strongly correlated suggest that unrealistic models were used in earlier calculations of the total power generated in the magnetosphere by an incoherent Cherenkov process. Therefore it is considered worthwhile to study the Cherenkov radiation again. This paper discusses a model for a region in space in which the auroral hiss is believed to be generated. It is shown that the total power generated in this region is comparable to the observed power, and it is concluded that auroral hiss may be generated by incoherent Cherenkov radiation from electrons with energies of the order of 1 keV. (auth)

15422 A MASS SPECTROMETRIC DETERMINATION OF THE NEUTRAL CONSTITUENTS IN THE LOWER THERMOSPHERE ABOVE SARDINIA. Mauersberger, K.; Mueller, D.; Offermann, D.; von Zahn, U. (Univ., Bonn). J. Geophys. Res., 73: 1071-6(Feb. 1, 1968).

On December 11, 1965, at 0505 MET an ESRO Centaure rocket (ESRO C07/2) was launched from the range of Salto di Quirra, Sardinia, carrying a quadrupole mass filter. The number densities of N_2, O_2, O, and Ar were determined in the altitude range from 112 to 158 km. A high content of atomic oxygen was found, as can be seen from the number density ratio $n(O)/n(O_2) = 7.3$ at 150 km. The relative Ar concentration was low, this indicating an onset of diffusive separation well below 110 km. (auth)

15423 ELECTRIC CURRENTS INDUCED BY NONPERIODIC WINDS IN THE IONOSPHERE. I. Maeda, Hiroshi (Goddard Space Flight Center, New York); Murata, Hiroo. J. Geophys. Res., 73: 1077-92(Feb. 1, 1968).

Electric currents induced by nonperiodic winds in the ionosphere were calculated for the case of incoincidence of the Earth's rotational and magnetic axes, based on a realistic model of the upper atmosphere. Main results obtained are as follows: (1) Sq-like current systems changing with universal time are produced, and the intensity of main vortices is about one-tenth of that of the Sq field for a typical wind velocity of 10 m/sec. (2) Of the two components of nonperiodic winds, the meridional component is more effective in producing current systems. (3) The position of main current vortices is controlled by the distributions of ionospheric conductivity and of wind velocity and the degree of influence of these two is different for different profiles of winds. (4) The intensity of main vortices changes with longitude in such a manner that the maximum intensity occurs in the North and South American zone and the minimum in the Asian and Oceanian zone, being in agreement with that of the Sq field. (5) No remarkable difference can be seen in the results obtained by using different coordinate systems. (auth)

15424 OBSERVATIONS OF VLF HISS AT VERY LOW L VALUES. Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 1096-1101(Feb. 1, 1968).

Observations of intense bursts of vlf radio noise at low altitudes near the magnetic equator are reported, using data from the Injun 3 satellite. The spectral characteristics of these radio noise events typically consist of hiss extending from about 1 kHz to above 8.8 kHz. These equatorial ulf hiss events are very similar to vlf hiss commonly found near the auroral zone. (W.D.M.)

15425 COMMENTS ON LOCAL ELECTRON CONCENTRATION DETERMINATION FROM DOPPLER DISPERSION MEASUREMENTS OF SATELLITE RADIO BEACONS. Ross, W. J. (Pennsylvania State Univ., University Park); Garriott, O. K.; de Mendonca, F.; da Rosa, A. V. J. Geophys. Res., 73: 1102-6 (Feb. 1, 1968).

From time to time attempts have been made to use dispersion measurements for the determination of electron concentration in the vicinity of the satellite transmitter. This note calls attention to the errors inherent in experiments of this kind and urges extreme caution both in their use and in the acceptance of results derived from them. A brief summary of the conclusions concerning this class of experiment is presented. (W.D.M.)

15426 UPPER LIMITS TO THE 304- AND 584-A NIGHT HELIUM GLOW. Bowyer, C. Stuart (Univ. of California, Berkeley); Livingston, P. M.; Price, R. D. J. Geophys. Res., 73: 1107-11(Feb. 1, 1968).

In the experiment reported, a metallic film on the order of 1000 Å thick was used as a bandpass filter to isolate the helium lines. The film was supported by a scintillator that was in optical contact with a photomultiplier tube. Similar detectors had been developed for laboratory studies of the helium resonant lines. Rejection ratios for the hydrogen line over the helium lines can reach as high as several thousand for these detectors. In addition, it is possible to determine the individual contributions of the 304- and 584-Å lines. (W.D.M.)

15427 UNCOUPLING OF PARALLEL AND PERPENDICULAR PARTICLE MOTION IN A NEUTRAL SHEET. Speiser, T. W. (Pennsylvania State Univ., University Park). J. Geophys. Res., 73: 1112-13(Feb. 1, 1968).

It has been suggested that the perpendicular–oscillatory motion of a particle within the neutral sheet is essentially uncoupled from the particle's motion parallel to the sheet. The object of the present note is to examine this perpendicular motion in more detail to determine the extent of this uncoupling. (W.D.M.)

15428 ELECTRON CONCENTRATION PROFILES DURING SUNSPOT MAXIMUM AND MINIMUM. Lootens, Harold T.; Prenatt, Raymond E. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). J. Geophys. Res., 73: 1114(Feb. 1, 1968).

This letter describes two electron concentration profiles derived from data recorded at Fort Churchhill. One profile was computed using the Dovap trajectory comparison technique, with data recorded in 1958 during a period of maximum sunspot activity. The other profile was computed from data produced by a rocket-borne, two-frequency propagation experiment, flown in 1964 during a period of minimum sunspot activity. (W.D.M.)

15429 MAPPING OF THE EARTH'S BOW SHOCK AND MAGNETIC TAIL BY EXPLORER 33. Behannon, Kenneth W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 907-30(Feb. 1, 1968).

The Explorer 33 satellite was launched July 1, 1966, and was injected into a highly elliptical earth orbit. The Goddard Space Flight Center magnetic field experiment onboard the spacecraft consists of a triaxial fluxgate sensor with a maximum dynamic range of ±64 gammas and a sensitivity of ±0.25 gamma along each axis. Because of the initial apogee–Earth–Sun angle of 118° west of the Sun, the first 8 orbits of Explorer 33 (July 1 to November 11, 1966) mapped the Earth's magnetosheath and magnetic tail from the western flank of the bow shock to the eastern flank. This mapping of the geomagnetic tail out to 80 R_E established that the tail extends beyond the lunar orbital distance. Explorer 33 has also found that the Earth's bow shock is still a detectable boundary between the interplanetary magnetic field and the downstream magnetosheath at a geocentric distance of 75.7 R_E. The measurements have further suggested that the cross section of the geomagnetic tail is probably not cylindrical and have shown that the magnetic field magnitude in the tail decreases with distance down the tail from the Earth. (auth)

15430 CORRELATION OF ≥ 30-keV ELECTRON PULSES AND MAGNETIC FIELDS IN THE MAGNETO-SHEATH AND BEYOND. Jokipii, J. R. (Univ. of Chicago). J. Geophys. Res., 73: 931-41 (Feb. 1, 1968).

Simultaneous energetic electron and magnetometer data, obtained in the magnetosheath and beyond the bow shock on the IMP 1 satellite, were analyzed. Within the 20-second time resolution available, it is concluded that no unique local correlation exists between the electron pulses and the magnetic field intensity. However, the general ambient field tends to be more disturbed and be directed more nearly along the Sun–Earth line during periods when pulses are present than otherwise. Three distinct types of electron events are observed. The first type of event is found in the magnetosheath and may be due to electrons convected with the solar plasma. The second type is clearly associated with multiple crossings of the bow shock. The third type of event apparently occurs beyond the bow shock and is associated with magnetic field fluctuations with periods $\gtrsim$10 seconds. The observations require that the excess particle energy density during pulses be somewhat less than that of the ambient magnetic field. It is thus concluded that the energy spectra of electrons observed in the magnetosheath and beyond are different from those observed in the Earth's magnetic tail. Several magnetic neutral sheets observed in interplanetary space were not associated with enhanced counting rates. (auth)

15431 OBSERVATIONS OF ELECTRONS IN THE EARTH'S MAGNETOTAIL BY VELA LAUNCH 2 SATELLITES. Montgomery, Michael D. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res., 73: 871-89(Feb. 1, 1968). (LA-DC-9079).

Vela satellite observations of energetic electrons (>40 keV) at 17 R_E in the earth's magnetic tail are presented. Spatial distributions normalized with respect to sample time show the size and shape of the region within which the energetic electrons were found. Power-law and Maxwell–Boltzmann least-squares fits are made to the energy spectra that show that during disturbed periods the power-law fits are better, while during quiet times the energy distributions above 40 keV tend to thermalize. Detailed time histories of energy distributions of electrons from 0.3 to 200 keV show that the energetic electrons do not form a smooth high-energy tail, but are at times a separate energy distribution with a secondary flux maximum that occurs at ≈10 keV. The high-energy tail of the electron distribution may result from "local" acceleration mechanisms that operate most often on the dawn side of the magnetotail. (auth)

15432 ELECTRONS WITHIN THE NEUTRAL SHEET OF THE MAGNETOSPHERIC TAIL. Murayama, T.; Simpson, J. A. (Univ. of Chicago). J. Geophys. Res., 73: 891-905(Feb. 1, 1968).

The distribution, intensity, and energy spectra of electrons near and within the neutral sheet are studied using the simultaneous measurements of the University of Chicago Au–Si surface-barrier detector (electron energies >160 keV) and the University of California detector (electron energies >45 keV) on the IMP 1 satellite in 1964. Based upon the position of neutral sheet crossings determined by Speiser and Ness from the IMP 1 magnetometer, electron fluxes >160 keV are observed in all of the 20 analyzed neutral sheet crossings. It is shown why these results were not obtained by Anderson and Ness. The electron flux generally has a peak in the neutral sheet that is about twice the amplitude of adjacent regions in the tail. The neutral sheet thickness exceeds the gyroradius of 200-keV electrons by a factor 5. The electron distributions in space and time indicate that they are continuously present within the neutral sheet. A comparison of the energy spectra of electrons in the sheet with electron islands found by Anderson widely distributed in the tail shows that the neutral sheet electrons have energy spectra that are at least as flat as for the islands, and extend in energy above 200 keV. The dependence of neutral sheet electron fluxes upon the radial distance from the magnetic dipole and upon geomagnetic field disturbances is investigated. The present evidence for neutral sheet electrons indicates either (a) that the sheet is well-connected to a region of electron acceleration in the magnetosphere and the sheet behaves like a corridor or channel for electron escape, or alternatively, (b) that the electrons are accelerated in the neutral sheet. (auth)

15433 PHOTOELECTRON HEATING EFFICIENCY IN THE IONOSPHERE. Hanson, W. B. (Southwest Center for Advanced Studies, Dallas); Cohen, Robert. J. Geophys. Res., 73: 831-40 (Feb. 1, 1968).

Thomson scatter data taken at the Jicamarca Radar Observatory (11.95°S., 76.87°W.; surface dip ~2°) during January 1967 are used to derive the heating efficiency of photoelectrons. It is found that a limiting value of approximately 15 eV per ion pair formed is deposited in the electron gas at altitudes above 300 km. This value decreases to less than 1 eV per photoelectron near 200 km. The rapid change of heating efficiency with altitude causes the peak in the electron temperature to be at a rather higher altitude than previously estimated. Thermal coupling between ions and electrons is the dominant electron heat loss mechanism both above and below the altitude where the peak value of T_e occurs. To obtain reasonable values for the various F-region parameters it is necessary to assume that the electron loss coefficient decreases with temperature if laboratory rate coefficients measured at room temperature are used. (auth)

15434 GEOGRAPHIC DISTRIBUTION OF F-REGION ELECTRONS WITH ABOUT 10-eV ENERGY. Knudsen, William C. (Lockheed Research Lab., Palo Alto, Calif.). J. Geophys. Res., 73: 841-56(Feb. 1, 1968).

Large fluxes of about 10-eV electrons with magnitude in the range of 10^{10} to 10^{31} cm^{-2} sec^{-1} were measured by a retarding potential analyzer mounted on an oriented satellite. The restricted geographic locations and altitudes at which the large fluxes were observed suggest that the fluxes are produced by the interaction of radiation belt particles with the upper atmosphere. Two regions of intense electron flux occurred at approximately L = 1.1 in the southern hemisphere at an altitude of 270 km with maxima at 90°W and 110°E. The maximum at 90°W is presumed to be produced by more energetic electrons drifting eastward at the bottom of the inner radiation belt and interacting with the atmosphere. Maximum energy flux observed within the instrumental energy window was 1 erg/cm^2 sec. Enhanced ambient electron concentration, ion temperature, and negative vehicle potential accompanied the large electron flux. A local electron temperature of 20,000°K would explain the observed vehicle potential and electron flux. The measured ion temperature in the maximum was of the order of 1000°K above expected neutral temperatures and measured ion temperature on either side. A less intense but still distinct region of electron flux was evident at about L = 1.7 in the southern hemisphere at 130° west longitude. This region, also characterized by enhanced ion temperature and electron concentration, is presumed to be produced by inner radiation belt electrons at the center of the belt interacting with the atmosphere. A region of intense electron flux occurred over Siberia with center at about 60°N and 90°E and at an altitude of 270 km. The maximum occurred at about L = 3.6, which is approximately the center of the outer radiation belt; the longitude of the maximum is that at which the mirror altitude of a particle drifting around the earth is largest. Energy flux

within the instrumental energy window was 0.25 erg/cm² sec at the center of the region. A relative minimum in electron concentration and maximum in negative vehicle potential accompanied this maximum in electron flux. Results of this study suggest that ionization produced at L = 1.1 by energetic particles may contribute to the ionospheric equatorial magnetic anomaly. Interaction of inner radiation belt electrons with the atmosphere west of the South Atlantic magnetic anomaly produces a knob or knobs of electron concentration there with maximum concentration between 90 and 180°W longitude. Maximum ionization produced by the interaction is about 3×10^5 cm^{-3}. (auth)

15435 AIRGLOW OBSERVATIONS FROM OSO-B2 SATELLITE. Sparrow, J. G.; Ney, E. P.; Burnett, G. B.; Stoddart, J. W. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 857-66(Feb. 1, 1968).

Four photometers sensitive to three wide spectral bands observed the continuum airglow in profile once per orbit from the satellite OSO-B2. The tangential enhancement (factor of 35) gave good discrimination against zodiacal light and background starlight. Airglow intensity in the astronomical visible spectral region varied between 0.1 and 0.9 R/A and from 0.06 to 0.5 R/A in the blue spectral region. No significant latitude variation was found although a considerable temporal change occurred during the ten months of satellite operation. No correlation was found between airglow intensity and the South Atlantic geomagnetic anomaly or with solar events. (auth)

15436 A SIMPLE DERIVATION OF THE DESSLER-PARKER-SCKOPKE RELATION. Olbert, S.; Siscoe, G. L.; Vasyliunas, V. M. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 73: 1115-16(Feb. 1, 1968).

The purpose of this note is to point out that the result of Sckopke (J. Geophys. Res., 71: 3125(1966)) is obtained by a straightforward application of the virial theorem. The approach has three advantages: firstly, it leads to the equation $B_Z^m/B^e = -\frac{2}{3}(U_K/U_D)$(where U_K is the total particle kinetic energy, B^e is the equatorial value of the undistorted geomagnetic field, and U_D is the total magnetic energy in the undistorted geomagnetic field above the Earth's surface) with very little mathematical effort; secondly, it shows that the equation has more general validity than previously supposed; and thirdly, it permits a derivation of a more rigorous expression for B_Z^m. (W.D.M.)

15437 THE EQUATORIAL ANOMALY IN THE F_2 REGION OF THE IONOSPHERE. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Inst. Telecommun. Eng., 12: 245-56(1966).

A review is given of the behavior of the F2 layer of the ionosphere, often referred to as geomagnetic anomaly, geomagnetic distortion, or Appleton anomaly. Equatorial and solar activity are examined, followed by a discussion of the seasonal variation of the equatorial anomaly, its diurnal development, and its relation to magnetic activity. The equatorial anomaly and its relation to the lunar phase and different heights of the ionosphere, and the longitudinal variation of the anomaly are also discussed. (IAA)

15438 SPEED OF FADING OF RADIO WAVES REFLECTED FROM THE IONOSPHERE OVER AHMEDABAD. Patel, C. M. (Physical Research Lab., Ahmedabad, India). J. Inst. Telecommun. Eng., 12: 511-15(1966).

Fading records obtained on 2.6 Mc by the method of closely spaced receivers were used to measure horizontal drifts in the ionosphere over Ahmedabad. The data for the period March 1960 to February 1961 were analyzed to calculate the semiangle θ of the down-coming waves and the approximate size of the ionospheric irregularities. It is shown that a linear relation between the fading rate and drift speed holds good for E, E_s, and F-region reflections. Histograms showing the statistical distribution of θ are drawn for daytime and nighttime observations and for different seasons. These results are compared with results obtained elsewhere. (IAA)

15439 DIRECT OBSERVATION OF THE IONOSPHERE WITH SOUNDING ROCKET K-9M-20. Hirao, Kunio; Miyazaki, Shigeru. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 3: 489-99(July 1967). (In Japanese).

A discussion is given of the results of a rocket probe carried out on Oct. 20, 1966, from the Kagoshima Space Center. The resonance-probe method was used to obtain the electron-density profile, the Langmuir-probe method to obtain the ion-density profile, and the ac-probe method to obtain the electron temperature in the ionosphere at twilight at an altitude of 358 km. The results of the observations are presented and discussed. (IAA)

15440 ASYMMETRY OF THE DIURNAL VARIATIONS OF THE ELECTRON CONCENTRATION IN THE IONOSPHERE. Serafimov, Kiril (Geophysical Inst., Sofia); Samardzhiev, Dimit'r. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 11: 63-86 (1967). (In Bulgarian).

An analysis is given introducing the ratio of the electron concentration before and after the culmination of the Sun (for equal zenith angles) as the asymmetry parameter for the diurnal electron-concentration variations in the ionosphere. This ratio is studied on the basis of the complete system of balance equations for the α and β ionospheric layers, the asymmetry of the near-maximum portions of these layers, and the asymmetry of ionospheric absorption. General expressions for the asymmetry coefficient in the various cases are derived. (IAA)

15441 PLANETARY DISTRIBUTION AND ENERGY BALANCE OF THE COSMIC LAYER IN THE LOWER IONOSPHERE. Velinov, Petr. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 11: 87-102(1967). (In Russian).

An analysis is made of the changes in the electron production q(h) in the cosmic layer ($\sim 10^2$/cm^3) in the lower ionosphere. The ionizing power of cosmic rays is studied with respect to the geometric rigidity threshold, and its energy and geomagnetic latitude. Energy relations associated with the interaction of cosmic rays with the ionosphere are derived on the basis of considerations concerning the energy balance and planetary distribution of the cosmic layer. (IAA)

15442 DYNAMICS OF THE D REGION DURING THE SOLAR ECLIPSE OF MAY 20, 1966. Nestorov, Georgi (Geophysical Inst., Sofia). Izv. Geofiz. Inst., Bulg. Akad. Nauk, 11: 23-33 (1967). (In Bulgarian).

A discussion is presented of the changes of the total electromagnetic field of a frequency of 182 kHz observed over the path between Ankara and Sofia during the solar eclipse of May 20, 1966. It is shown that the reflection coefficient started to increase immediately after the first contact, reaching its maximum soon after totality. At the same time, the lower boundary of the D region rose gradually, reaching a height of 6.15 km from the quiet daytime ionosphere level during the maximum phase of the general increase. Qualitative estimates of the velocity and height of the discrete ionization levels necessary for signal reflection are obtained, and a complete analogy between the ionospheric effects of solar chromospheric flares and the ionospheric eclipse effects with respect to the "mobility" of the lower ionosphere was established. (IAA)

15443 PRELIMINARY RESULTS OF ATTEMPTS TO MEASURE NIGHT-TIME IONOSPHERIC ABSORPTION IN THE CASE OF QUASI-VERTICAL WAVE INCIDENCE. Nestorov, Georgi (Geophysical Inst., Sofia). Izv. Geofiz. Inst., Bulg. Akad. Nauk, 11: 35-9(1967). (In Bulgarian).

A discussion is given of nighttime absorption observations at 827 kHz during low solar activity, performed at angles of incidence of less than 10° for which the physical and geometrical path is clearly defined. The mountainous nature of the reception area ensured a strong absorption of the surface wave and accurate recording of the reflected ionospheric wave. Continuous control of the reflection region was made possible by the presence of an ionosonde in the middle of the path. Under these conditions it was possible to use the measurements of A1- and A3-type absorption to best advantage. It was found that the absorption has a maximum in the winter months and a minimum in the summer months. The summer minimum gives rise to signal reflections from the sporadic layers, as is attested by the excellent correlation between the probability of the appearance of nighttime sporadic layers and the absorption. (IAA)

15444 INVESTIGATION OF THE INFLUENCE OF SOLAR ACTIVITY ON TEMPERATURE CHANGE IN THE STRATOSPHERE. Geokhlanyan, T. Kh. Meteorol. Gidrol., No. 3, 60-9(1967). (In Russian).

The importance of solar corpuscular streams in warming the polar stratosphere during the winter months was investigated. Since the maximum of magnetic storms occurs during the same months as the stratospheric warming, temperature and magnetic data were correlated and analyzed. Satellite deceleration data, the results of rocket and radiosonde temperature observations, and the magnetic activity (K_p index) obtained in the period 1958–1963 served as indicators of corpuscular stream action. Though no general correlation was discerned between solar activity and stratospheric temperature, a definite correlation was noted during several instances of maximal geomagnetic disturbances. A temperature increase occurred one day after such intense magnetic storms. An estimate of the effect of solar activity on temperature variation was obtained by solving a system of hydrodynamic equations in cylindrical coordinates. Temperature fluctuations caused by short-period increases of magnetic activity are be-

lieved to propagate from the upper to the lower levels by means of a resonance effect. It is concluded that short-period variations of solar activity causing short-period temperature changes in the lower auroral boundary can have an effect on the stratospheric temperature. (ATD)

15445 POSSIBLE LUNAR X RAYS EXCITED BY TERRESTRIAL ELECTRONS. Hayakawa, Sachio. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 940-2(July 1966). (In Japanese).

An investigation is reported of lunar x rays excited by energetic electrons which occur in the tail of the magnetosphere where they bombard the lunar surface. Such electrons have fluxes which have been observed with values as high as $10^8/cm^2$ sec; the bremsstrahlung for x rays with k energy excited by such electrons at the lunar surface is as great as $4 \times 10^3(\Delta k/k)/cm^2$ sec. For example, the intensity of K x rays for silicon is about 5 keV/Δk multiplied by the intensity of the bremsstrahlung at the same energy level. It is hypothesized that the observation of such lunar x rays may provide information on electrons in the magnetosphere as well as on the chemical composition of the Moon. (IAA)

15446 DELAYED IONOSPHERIC D-REGION EFFECTS IN SHORT-WAVE FIELD INTENSITY RECORDINGS CAUSED BY NUCLEAR EXPLOSIONS. Nitzsche, P. (Heinrich Hertz Inst., Neustrelitz, Ger.). Z. Meteorol., 18: 449-51(1966). (In German).

A report is given on delayed D perturbations following the US and Soviet nuclear tests carried out during the period July–December 1962. In view of the absence of accurate information on the nuclear tests, the mechanisms of these highly delayed effects are theorized, mentioning the possibility that the nuclear explosion caused primarily a strong MHD perturbation, which in turn caused the sinking of the points of reflection of the captured particles, which finally led to a partial discharge of the outer radiation belt. (ATD)

15447 SOME DATA ON THE DRIFT OF NOCTURNAL SPORADIC CLOUDS IN THE E REGION OF THE IONOSPHERE OBTAINED FROM SHORT-WAVE FIELD-INTENSITY RECORDINGS. Nitsche, P. (Heinrich Hertz Inst., Neustrelitz, Ger.). Z. Meteorol., 18: 452-4(1966). (In German).

A discussion is given on the field-intensity measurements obtained over three measuring distances: Norddeich–Neustrelitz (393 km), Norddeich–Juliusruh (415 km), and Kiel–Neustrelitz (220 km). If the temporal displacements of the increases of the received field intensity as a result of E_s reflections, obtained in the recordings of these measuring distances are interpreted as the migration of nocturnal E_s ionizations, then a drift velocity of (60 ± 10) m/sec can be deduced from these data. The direction of the drift is preferentially toward SSW. (ATD)

15448 STABILITY OF THE EARTH'S RADIATION BELTS. Tverskoi, B. A. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 177-89(1967).

Translated from Geomagn. Aeron., 7: 226-42(1967).

The problem of the limit of the cyclotron instability of the Earth's radiation belts is examined with allowance for wave absorption in the ionosphere. A method of computing the increments in an inhomogeneous field, based on the perturbation theory, is presented. It is shown that the proton belt is stable, but intensity is close to critical in the vicinity of the maximum. Therefore, Alfvén waves may sometimes be excited. The main characteristics of waves generated by the proton zone correspond to the properties of type Pcl micropulsations. The level of critical electron fluxes in the inner zone is computed and it is shown that it agrees well with the observed distribution. Estimates are given of critical electron intensities in the outer zone and of the lifetime of electrons in the gap. (auth)

15449 GENERATION OF ELECTRIC FIELDS IN THE MAGNETOSPHERE AND ACCELERATION OF AURORAL PARTICLES. Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 190-3(1967).

Translated from Geomagn. Aeron., 7: 243-7(1967).

The problem of the rotation of the magnetosphere in the presence of a solar wind reduces to the problem of the rotation of a magnetized sphere in a cavity formed in an ideal conductor. The disturbing field of induced electric currents on the surface of the cavity is approximated in turn by the field of an auxiliary dipole imitating the effect of the solar wind. Estimates show that the difference in electric potentials along the lines of force of the geomagnetic field can reach several keV and can be partly responsible for the acceleration of auroral particles. A corresponding estimate for Jupiter gives a value three orders of magnitude higher. (auth)

15450 INFLUENCE OF THE EXTERNAL MAGNETIC FIELD ON THE SHAPE OF THE BOUNDARY BETWEEN A PLASMA STREAM AND A CAVITY WITH A PLANE DIPOLE. Samokhin, M. V. (Radio Engineering Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 194-9(1967).

Translated from Geomagn. Aeron., 7: 248-54(1967).

The shape of the boundary separating a plasma stream containing a frozen-in magnetic field from a cavity filled with the magnetic field of a plane dipole is determined. The cavity is found to be closed and resembles a crescent with a hemispherical projection on the convex side facing the plasma stream. If the outer field is parallel to the velocity vector of the stream, the boundary deflects inward in the polar regions and in the tail part in the vicinity of the equatorial plane. When the field is perpendicular to velocity, there are no cavities at the poles and in the tail portion, and the boundary of the tail is a circle. (auth)

15451 COULOMB RELAXATION OF RADIATION-BELT ELECTRONS IN THE DENSE LAYERS OF THE ATMOSPHERE. Timofeev, G. A. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 200-6(1967).

Translated from Geomagn. Aeron., 7: 255-63(1967).

The kinetic equation is used to analyze the time dependence of electron distributions determined by Coulomb interactions. The lifetime of electrons of energy 1 MeV at mirror altitudes of 350, 500, and 750 km is obtained for various geomagnetic lines of force. (auth)

15452 ANALYTICAL REPRESENTATION OF THE GEOMAGNETIC FIELD ACCORDING TO COSMOS 49 DATA. I. Tyurmina, L. O.; Cherevko, T. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 207-10(1967).

Translated from Geomagn. Aeron., 7: 264-8(1967).

A possible method of obtaining an analytical representation of the geomagnetic field from satellite data is described. The results of analyses of three samples, consisting of 1680 points each, are reported. It is shown that the analysis performed on one of the samples for six harmonics represents the field of the other samples with an error of about ±50 γ. (auth)

15453 TOPOLOGY OF THE GEOMAGNETIC FIELD AT A DISTANCE OF 3 TO 7 R_e ACCORDING TO ELEKTRON 2 DATA. Shevnin, A. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 260-4(1967).

Translated from Geomagn. Aeron., 7: 328-33(1967).

The projections of the vectors of the disturbed field onto the plane parallel to the geomagnetic equator and the plane of the geomagnetic meridian were obtained for five passes of the satellite from February 10–14, 1964. The behavior of the disturbed field in the days of low magnetic activity in question depends on local time. The behavior of the disturbed field on the night side generally supports the ring current hypothesis, whereas on the morning side in addition to the ring current one has a situation where the magnetic lines of force are blown to the night side and are pressed against the plane of the geomagnetic equator. (auth)

15454 DURATION OF THE INITIAL PHASE OF A GEOMAGNETIC STORM. Antsilevich, M. G. (Inst of Nuclear Physics, Tashkent). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 265-8 (1967).

Translated from Geomagn. Aeron., 7: 334-8(1967).

The duration of the initial phase of a magnetic storm is estimated on the basis of observations at 59 magnetic observatories during the IGY–IGC period. The average duration of the initial phase at low latitudes is 35 min and at high latitudes it is ~20 min. (auth)

15455 NONLINEAR THEORY OF THE CYCLOTRON INSTABILITY OF THE RADIATION BELTS OF THE EARTH. Trakhtengerts, V. Yu. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 269-71(1967).

Translated from Geomagn. Aeron., 7: 339-40(1967).

The purpose of the present note is to apply the results of Andronov, et al. (Geomagn. i Aeronomiya, 4, No. 2, 233(1964)) and Trakhtengerts (Geomagn. i Aeronomiya, 6, No. 5, 827(1967)) to large R(R ~ 1). A situation where R ~ 1 is possible when plasma waveguides, extending along the H_0 of the region of enhanced (reduced) ionization, appear in the magnetosphere along which the ulf waves can propagate practically without losses. Furthermore, R apparently increases considerably on the night side of the magnetosphere. (W.D.M.)

15456 NONDIPOLE PART OF THE GEOMAGNETIC FIELD AFFECTS THE MAGNETOSPHERE BOUNDARY. Kalinin, Yu. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 271-2(1967).

Translated from Geomagn. Aeron., 7: 341(1967).

The results of magnetic observations by Explorer 12 reveal the existence of a nondipole part of the geomagnetic field at the magnetosphere boundary. The question of whether the dependence of R (the geocentric distance to the boundary) on UT(Universal Time) is fictitious was examined and the different average geomagnetic activity levels at various hours of UT were determined. For this purpose the values of the A_p index were taken for 3-hr periods to which the R values belonged. After grouping them by hours of UT it was found that the distribution of a_p is in fact insufficiently uniform (a_p varies from 4 to 50). After this, eight R values relating to 3-hr intervals with $a_p \geq 39$ were excluded from analysis. For the remaining 61 R values the a_p indices, averaged over the hours of UT, gave a variation in the range from 4 to 12. After the remaining 61 R values were averaged over the hours of UT and after the R series was smoothed, values were obtained which are presented. (W.D.M.)

15457 STUDY OF THE GEOMAGNETIC FIELD BY MEANS OF RADIATION BELTS. Kuznetsov, S. N. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 272-3(1967).

Translated from Geomagn. Aeron., 7: 342-3(1967).

A belt of electrons with $E_e > 6$ MeV was detected during the flight of Elektron satellites. The maximum of this belt was found at $L = 2.75 \pm 0.1$ everywhere, except in the region of the South Atlantic anomaly. The half-width of the belt was $\Delta L \approx 0.4$. The origin of the belt is not clear; it is assumed that it formed during the magnetic storm of Sept. 23–26, 1963. This belt was stable; the intensity of electrons was maintained in it over 1.5 months and the belt itself did not move from shell to shell. Therefore, it was possible to use this belt to study the drift shells of electrons. (W.D.M.)

15458 CHARACTERISTICS OF THE DISPERSION OF PROTON WHISTLERS DETECTED BY INJUN 3 AND ALOUETTE 1. Gul'el'mi, A. V. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 274-5(1967).

Translated from Geomagn. Aeron., 7: 344(1967).

Proton whistlers can be used for determining the concentration of ions and the magnetic field intensity in the plasma surrounding a satellite. This is possible because as the instantaneous frequency approached the gyrofrequency of the protons, the character of the dispersion of ion cyclotron waves is very sensitive to a change in plasma parameters. But, in this frequency range, dispersion also depends significantly on the velocity of the plasma relative to the observer. This is probably the explanation for the characteristic of the dispersion of proton whistlers examined in the present note. (W.D.M.)

15459 VARIATIONS OF THE N(h) PARAMETERS DURING THE IGY AND IQSY PERIODS. Potapova, N. I.; Shapiro, B. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 275-7(1967).

Translated from Geomagn. Aeron., 7: 345-7(1967).

Variations of the N(h) parameters during the IGY and IQSY periods are given as a function of season, location, and solar activity. (W.D.M.)

15460 DEPENDENCE OF f_0E_s ON THE MAGNITUDE OF ABSORPTION. Kerblay, T. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 278-80(1967).

Translated from Geomagn. Aeron., 7: 348-50(1967).

The relationship between the cutoff frequencies of the sporadic E layer, f_0E_s, measured at an ionospheric station, and absorption can be of two kinds. The character of the relationship between f_0E_s and absorption in both cases is examined on the basis of data from several middle- and high-latitude ionospheric stations. (W.D.M.)

15461 WINTER IONOSPHERIC DRIFTS IN A QUIET-SUN PERIOD. Kazimirovskii, E. S.; Kokourov, V. D.; Chernobrovkina, N. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 280-2(1967).

Translated from Geomagn. Aeron., 7: 351-2(1967).

A program was initiated to measure drift at seasonal monthly intervals, centered about the dates of the solstice and equinox, around the clock with at least two recording sessions per hour. The present note examines the material obtained from measurements by this program during the winter solstices of 1965-1966 at Irkutsk during relatively low solar activity (relative sunspot number of ~30). The speed and direction of drift were determined from 659 records. (W.D.M.)

15462 STUDY OF THE EQUATORIAL ANOMALY OF THE IONOSPHERE IN THE EAST ASIAN ZONE OF THE PACIFIC OCEAN. Artem'eva, G. M.; Korobkov, Yu. S.; Pisareva, V. V. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 282-5(1967).

Translated from Geomagn. Aeron., 7: 353-6(1967).

The ionosphere was studied over the Pacific from May through August, 1962, by vertical soundings by an AIS station on board a ship. The coordinates of the ship varied from 140 to 204°E and from 18°S to 40°N. The data collected were used to study the geomagnetic anomaly in the ionosphere. (W.D.M.)

15463 SPECTRA OF ATMOSPHERICS AT ULTRA-LOW FREQUENCIES DURING THE NIGHTTIME. Mikhailova, G. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 285-7(1967).

Translated from Geomagn. Aeron., 7: 357-8(1967).

The amplitude spectra of the high-frequency part of an atmospheric in the range 2 to 30 kHz at night at distances of 1000 to 4000 km from the source were examined in (Mikhailova. Geomagn. i Aeronomiya, 1965, 5: No. 1. 183). In the present article these data are generalized over a brooder frequency range, from 70 Hz to 30 kHz. (W.D.M.)

15464 LUNAR-PERIODIC VARIATION OF THE MAGNETIC FIELD AT HEISS ISLAND. Shneer, V. S. (Arctic and Antartic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 288-90(1967).

Translated from Geomagn. Aeron., 7: 359-61(1967).

Lunar-diurnal variations have hardly been studied in the polar regions, probably because the high magnetic activity masks the weak lunar variation which decreases toward high latitudes. The quietest months (winter) in the most magnetically quiet years on Heiss Island (1961–1962) were selected for study. Regrouping by lunar days was achieved using the Chapman–Bartels method for the variations of the D, H, and Z components. After the average seasonal values were computed (Nov.–Dec. 1961 to Jan.–Feb. 1962), a semidiurnal wave was clearly revealed in all three components. The first two harmonics were determined from a harmonic analysis of the curves. The amplitude of the second harmonic of all components was found to be 2 to 4 times higher than that of the first. The phase of the second harmonic of D differed from that of the H component by almost exactly 180°. The phases of the Z and H components differed by 120°. (W.D.M.)

15465 CONSTRUCTION OF CURRENT SYSTEMS OF SOLAR-DIURNAL MAGNETIC VARIATIONS FOR PARTICULARLY QUIET DAYS BY GRAPHIC INTEGRATION. Rudneva, N. M. (Ionospheric Section, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 290-2(1967).

Translated from Geomagn. Aeron., 7: 362-3(1967).

To study the variability of S_q variations it is convenient to construct current systems that correspond to S_q variations on individual quiet days. The present article gives separate parts of the current systems of S_q variations for three hours of the most quiet successive days of August 22, 23, and 24, 1957. These days were selected after examination of magnetograms of observatories of the global network. The magnetic characteristic C_p was 0.1 for Aug. 22 and 0.0 for August 23 and 24. There were no polar disturbances on these days. (W.D.M.)

15466 MAGNETIC ACTIVITY AT MIDDLE AND LOW LATITUDES DURING THE IGY. Fel'dshtein, Ya. I.; Pavlovich, L. K.; Puolokainen, T. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 292-4(1967).

Translated from Geomagn. Aeron., 7: 364-6(1967).

A satisfactory index of magnetic activity for middle and low latitudes is $\tau_H\gamma$. The amplitudes of $\tau_H\gamma$ at middle- and low-latitude observatories over the world are used in the present study. Magnetic activity over the period from Nov. 1, 1957 through Oct. 31, 1958, was analyzed by seasons: winter (Nov. 57–Feb. 58), the equinox (March, April, Sept. and Oct. 1958), and summer (May to Aug. 1958) for five international days and for all days. There is practically no S_a on all days at many stations and, therefore, only disturbed days were used. (W.D.M.)

15467 SCHEME OF AN ELEMENTARY DISTURBANCE IN AURORAS ON THE DAY SIDE OF THE EARTH. Starkov, G. V.; Fel'dshtein, Ya. I. (Polar Geophysical Inst., Kola Branch, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 294-6(1967).

Translated from Geomagn. Aeron., 7: 367-8(1967).

A detailed scheme of the development of an auroral disturbance on the night side of the Earth has been given in (Annals of the IGY, 38 (1965)). To obtain a planetary picture, the results of observations at high-latitude stations whose data will give an idea of the variations on the day side must be used. Therefore,

the scheme of the development of an auroral disturbance in the above was supplemented from ascafilms taken around the clock at Piramida and Churchhill. Fifteen magnetic DP disturbances from Dec. 1958 to Jan. 1959, representing negative bay-like disturbances of intensity 100 to 500 γ on the night side of the Earth and preceded by quiet periods, were selected for study. This selection made it possible to determine the commencement of a storm more accurately and excluded the superposition of other disturbances. (W.D.M.)

15468 FIELD OF POLAR DISTURBANCES AT HIGH LATITUDES. Maisuradze, P. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 296-9(1967).
Translated from Geomagn. Aeron., 7: 369-72(1967).

Taking advantage of the increase in the number of stations during the IGY, a study was undertaken of the dynamics of current systems as a function of the phase of D_{st} variations at low-latitude stations. The method of analysis used involved the construction of synoptic charts of successive instants of the disturbed field. (W.D.M.)

15469 MAGNETIC ACTIVITY AT HIGH LATITUDES IN THE NORTHERN HEMISPHERE DURING THE IGY. Afonina, R. G.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 299-302(1967).
Translated from Geomagn. Aeron., 7: 373-5(1967).

To determine the space–time patterns of the K index, the distribution of equivalent amplitudes of the K indices during the IGY from the data of 21 high-latitude stations in the Northern Hemisphere, given previously and taken directly from magnetograms, was analyzed. (W.D.M.)

15470 RELATIONSHIP BETWEEN Pi2 PULSATIONS OF THE GEOMAGNETIC FIELD AND PULSATIONS IN THE INTENSITY OF AURORAL LUMINESCENCE. Namgaladze, A. N.; Raspopov, O. M.; Roldugin, V. K. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 302-4(1967).
Translated from Geomagn. Aeron., 7: 376-7(1967).

The coincidence in the time of excitation of Pi2 pulsations and of the development of bay-like geomagnetic field disturbances, as well as the close relationship between the latter and the intensity of auroral luminescence suggest the possibility of detecting pulsations in the intensity of auroral luminescence with a period similar to that of Pi2. It is noted that a good correlation between irregular geomagnetic field pulsations, Pi1, and auroral scintillations has been found earlier. To verify this assumption, photometric records made with a zenith photometer at Loparskaya Observatory and the magnetograms of short-period geomagnetic field pulsations at Lovozero in Feb.–Mar. 1964 and Feb.–Mar. 1965 were analyzed and compared. Furthermore, the results of simultaneous photometric and magnetotelluric observations, obtained by Skrynnikov in 1963 at Lovozero, were analyzed. (W.D.M.)

15471 MAGNETIC CHART OF THE BRAZILIAN ANOMALY. Konovalova, L. V.; Nalivaiko, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 318-20(1967).
Translated from Geomagn. Aeron., 7: 394-5(1967).

The Cosmos 26 and 49 satellites measured the magnetic field with proton magnetometers according to the World Magnetic Survey program. The region of the Brazilian magnetic anomaly was covered by a dense network of measurements which were used to construct the magnetic chart of the anomaly. The need for such a chart is governed by the interest shown in this anomaly in view of the discovery near the Brazilian coast of a region with enhanced radiation intensity, whose study is of interest for radiation belt theory. The central part of the anomaly, $\varphi = 5$ to 40°S, $\lambda = 20$ to 70°W, was selected for constructing the chart in the present paper. (W.D.M.)

15472 FINE STRUCTURE AND POLARIZATION OF PP (Pc1) AT LOVOZERO. Lyatskii, V. B.; Selivanov, V. P. (Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 304-5(1967).
Translated from Geomagn. Aeron., 7: 378-9(1967).

In studying standard records of Earth currents taken at a paper speed of 0.5 mm/sec at Lovozero from Jan. 1961 through June 1965, 38 cases of very clearly defined PP necklaces were found. The forms of the recurrent pearls were copied and the periods of fluctuations were plotted above them. In studying all 38 periodograms various patterns were found. To study the polarization of PP, several recording sessions of these pulsations in Earth currents were held at Lovozero in 1964–65 at a paper speed of 2 to 3 mm/sec. A comparison of the polarizations of PP in the magnetic and electric fields of the Earth from these two records showed good agreement. A total of 21 PP series and necklaces were studied. (W.D.M.)

15473 INSTALLATION FOR THE MULTIPLE-FREQUENCY SOUNDING OF THE IONOSPHERE. Afraimovich, E. L.; Kudelin, G. M. (Ionospheric Section, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 320-2(1967).
Translated from Geomagn. Aeron., 7: 396(1967).

An installation for multiple-frequency sounding of the ionosphere, operating in a frequency scanning range 50 kHz to 15–20 MHz, is described. The equipment operates from an SP-3 ionospheric station. The repetition frequency of sounding pulses is increased to 60 kHz. Automatic recording and data processing are achieved by the data processing system which includes a general-purpose digital computer. (W.D.M.)

15474 MOTION OF A MONOPOLE IN A MAGNETIC DIPOLE FIELD. Dorman, L. I.; Okulov, Yu. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 211-18(1967).
Translated from Geomagn. Aeron., 7: 269-77(1967).

It is shown that the theory of motion of magnetic charges in a dipole field differs significantly from the corresponding problem for electric particles. In particular, the cutoff rigidity and Störmer cone concepts have no meaning for a monopole. An allowed cone for magnetic particles is introduced and the distribution function of magnetic charges in a dipole field is found. (auth)

15475 ABSORPTION OF THE ENERGY OF AN ELECTRON BEAM IN THE UPPER ATMOSPHERE. Lazarev, V. I. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 219-23(1967).
Translated from Geomagn. Aeron., 7: 278-83(1967).

An empirical function is derived for the energy absorption of an electron beam in matter. The energy distribution of an electron beam which is adsorbed as it travels through air layers of different mass, computed on the basis of this function, is compared with the results of experimental measurements of this quantity. A formula is obtained for computing the ionization rate at various levels in the upper atmosphere during injection of electron beams of various energies. (auth)

15476 MEASUREMENT OF THE TOTAL NUMBER OF ELECTRONS IN THE IONOSPHERE AND OF ITS GRADIENTS FROM THE RECORDS OF SIGNALS FROM ELEKTRON SATELLITES. Misyura, V. A.; Solodovnikov, G. K.; Migunov, V. M. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 224-9(1967).
Translated from Geomagn. Aeron., 7: 284-90(1967).

A method is described and the results are reported of measurements of the total number of electrons in a vertical column of the ionosphere, of its horizontal gradients, the equivalent heights of the outer ionosphere, and its vertical profiles. The measurements were made by processing the records of the Faraday effect at close frequencies and the reduced phase difference of coherent radio waves emitted by the "Mayak" radio station on Elektron 1 and Elektron 3. The dependence of ionospheric parameters on the observation time and the time of day obtained in this study and relating to the middle latitudes of the Soviet Union at low solar activity (February, March, and November 1964) are compared with data for high solar activity (1959), obtained from observations of signals from three satellites. (auth)

15477 EFFECT OF RADIO WAVES ON THE IONOSPHERE IN THE VICINITY OF THE F LAYER. Gurevich, A. V. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 230-6(1967).
Translated from Geomagn. Aeron., 7: 291-9(1967).

Ionospheric disturbances produced by a directional radio beam transmitted from Earth are examined. It is shown that for an averaged transmission power of an equivalent dipole of $W \gtrsim 5 \times 10^4$ to 10^5 kW the radio waves pierce the F layer of the ionosphere, as it were. In this case the critical F-layer frequency decreases substantially and the pattern of N = const surfaces is strongly distorted. (auth)

15478 SOME PROPERTIES OF METEOR ECHOES DURING FORWARD SCATTERING OF VHF. Triskova, L.; Samardziev, D. T. Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 237-40(1967).
Translated from Geomagn. Aeron., 7: 300-3(1967).

The results of observations of radio echoes from meteor trails during the forward scattering of vhf are reported. The diurnal and seasonal variations of the number of echoes and of total signal duration as well as the amplitude dependence of the number of echoes and the average duration of a single echo are given. (auth)

15479 MICROSTRUCTURE OF DISTURBANCE SOLAR-DIURNAL VARIATION. Loginov, G. A. (Polar Geophysical

Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.), 7: 241-4(1967).

Translated from Geomagn. Aeron., 7: 304-9(1967).

The structure of disturbance solar-diurnal variation is examined on the basis of micropulsations. It is found that geomagnetic disturbances are accompanied mainly by three types of micropulsations: Pc1, Pi2 + Pc1, and Pi1. The principal characteristics of these micropulsations are described. (auth)

15480 YADERNYI MAGNITNYI REZONANS V ZEMNOM POLE. (Nuclear Magnetic Resonance in the Earth's Field). Borodin, P. M.; Mel'nikov, A. V.; Morozov, A. A.; Chernyshev, Yu. S. Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1967. 232p.

The basic principles of nuclear magnetic resonance in the Earth's field are reviewed. Various methods for studying the phenomenon and its uses in physico-chemical, magnetometric, and other investigations are analyzed. The free and continuous nuclear precessions in the Earth's field are discussed. Geomagnetic measuring devices and applications of NMR methods in weak fields are evaluated. 411 references. (R.V.J.)

Low-Temperature Physics

Refer also to abstract 15504.

15481 (NYO-2150-20) AUDIO FREQUENCY ELECTROMAGNETIC PROPERTIES OF NORMAL AND SUPERCONDUCTING INDIUM. Johnson, Edwin Freeman (Cornell Univ., Ithaca, N. Y. Materials Science Center). June 1967. Contract AT-(30-1)-2150. 146p. Dep. CFSTI.

Thesis.

Helicon-like resonances have been observed in the intermediate state of high-purity polycrystalline indium, and an experimental investigation of their properties has been made. The dependence of the resonant amplitudes on the steady magnetic field and the temperature could be understood in terms of helicon theory providing the field-dependent relative permeability was included. Furthermore, the "Hall angle" derived by means of helicon expressions had a dependence on the steady magnetic field which was remarkably like that obtained by conventional techniques. In contrast, the "resistivity" and "Hall resistivity" calculated from the helicon expressions could not be understood by a reasonable model of the intermediate state. More experimentation is needed to clarify this point. As an extension of the studies of the intermediate state, the normal-state helicon was investigated in the limit of small steady magnetic fields ($\omega_c \tau \lesssim 1$). The resistivity and Hall coefficient derived from the helicon agreed (±15%) with those found by conventional measurements except at the lowest fields ($\omega_c \tau \lesssim 0.5$). The reasons for the discrepancies were not determined. (auth)

15482 (NYO-3029-23) OPERATION OF SUPERCONDUCTING INTERFERENCE DEVICES IN APPRECIABLE MAGNETIC FIELDS. Report No. 772. Beasley, M. R.; Webb, W. W. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 5, 1967. Contract AT(30-1)-3029. 13p. (CONF-670443-1). Dep. CFSTI.

From Symposium on the Physics of Superconducting Devices, Charlottesville, Va.

The problems which arise in developing a practical measuring device for measurement in strong fields are discussed. A device used to study flux creep in superconductors is described that is capable of resolving field changes of less than 10^{-7} gauss, with a 1 sec. time constant, in an applied field of 2500 gauss thus obtaining a field resolution of better than 1 part in 10^{10}. This is the superconducting quantum interference device (SQUID), which uses the dc Josephson effect. (M.H.R.)

15483 (ANL-Trans-564) MIXED ^{3}He AND ^{4}He CALORIMETER. VERY LOW TEMPERATURE CALORIMETRY. Testard, Olivier (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from report CEA-R-3073. 94p. Dep. CFSTI. JCL $8.60 fs, $3.02 mf.

Thesis. Submitted to Univ. of Paris, Orsay, France.

A general description of the cryostat and its operating principles is given. Discussions are given on the following: liquid nitrogen and helium-4 under atmospheric pressure, vacuum chamber, ^{4}He thermostat, ^{3}He thermostat, experimental chamber, temperature measurement, and other applications. (M.O.W.)

15484 DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP ON THE PHONON SPECTRUM AND ORDER-DISORDER EFFECTS. Enz, C. P.; Quattropani, A. (Univ., Geneva). Helv. Phys. Acta, 41: 54-60(1968).

The superconducting gap equation is solved for a general phonon spectrum in the weak coupling limit and at T = 0. The result is expressed by a limiting phonon momentum q_M which reduces the energy gap if $q_M < 2\,k_F$. An application to ordered and disordered alloys is discussed. (auth)

15485 APPLICATION OF ^{3}He TO PRODUCE VERY LOW TEMPERATURES. Trojnar, Eugeniusz. Postepy Fiz., 18: 691-702(1967). (In Polish).

This review paper deals with methods of using helium-3 as a refrigerant. A helium-3 evaporation cryostat for the temperature range 1.0 to 0.3°K and a refrigerator based on continuous dissolving of ^{3}He in ^{4}He for producing superlow temperatures (below 0.3°K) are described. Some remarks on the possible development of these methods are given. (auth)

15486 INFLUENCE OF THE CURRENT ON ELECTRON TUNNELING INTO A THIN SUPERCONDUCTING FILM. Uchiho, Kousuke (OKI Electric Co., Ltd., Tokyo); Nakaya, Shigehisa; Shigi, Toyoichiro. J. Phys. Soc. Jap., 24: 476-9(Mar. 1968).

An anomaly has been found in the current-voltage characteristics of the electron tunneling in a cross-type Sn/SnOx/Pb junction with a small tunneling resistance and a very thin tin film, which was proved to correspond to the superconducting-to-normal transition in the tin film. Some properties of the anomaly were also examined. It is pointed out that as the electron tunneling method requires relatively large current through the junction with a small tunnel resistance in order to measure the energy gap directly, the superconducting state of a very thin film is disturbed by this tunnel current. (auth)

15487 COHERENT STATES IN THE THEORY OF SUPERFLUIDITY. Langer, J. S. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 167: 183-90(Mar. 5, 1968).

It is shown that the coherent-state representation of a many-boson wave function may be identified with the order-parameter function conventionally used to describe a superfluid. The statistical mechanics of the many boson system is reformulated in terms of the coherent states, and a theory of the Ginzburg-Landau form is recovered in an obvious approximation. The formalism is particularly useful for describing metastable states of finite superflow and the fluctuations which may cause spontaneous decay of such states. (auth)

15488 COLLECTIVE MODES OF VORTEX LATTICES. Reatto, L. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3669. Phys. Rev., 167: 191-202(Mar. 5, 1968).

The dynamics of lattices of rectilinear vortices both in neutral systems (ideal classical fluids and He II) and in charged systems (type-II superconductors) are studied. The model differs from those which have been studied until now in that it takes into account that a perturbation in a system propagates with finite velocity; this effect is taken into account by the introduction of a retardation time between a displacement of the core of a vortex and the relative modification of its velocity field. Two different forms for the retardation are considered: one for a neutral system, in which the propagation of a perturbation has wave character, and one for a charged system, in which this propagation seems to have diffusion character. It is found that the stability of a vortex lattice is not modified by the presence of retardation. As regards the collective modes, only motions in which vortices do not bend are studied. In a neutral system, the retardation completely modifies the spectrum $\omega_R(k)$ for very small wave numbers k: one finds, indeed, $\lim_{k\to 0}\omega_R(k) \neq 0$; for larger wave vectors it introduces a damping of the collective modes. In a charged system, the collective modes become damped or aperiodic in the presence of retardation. (auth)

15489 PERIODIC CRITICAL VELOCITIES OF IONS IN LIQUID HELIUM II: TEMPERATURE DEPENDENCE. Bruschi, L.; Mazzoldi, P.; Santini, M. (Univ.; Padua). Phys. Rev., 167: 203-14(Mar. 5, 1968).

The behavior of positive- and negative-ion mobility in liquid helium as a function of the electric-field intensity has been investigated from 1.0 up to 2.3°K. Periodic discontinuities have been observed up to the λ point, while within the limits of the present technique no discontinuity has been observed above T_λ. It has been confirmed that the velocity at which the discontinuity occurs is temperature-independent below 1.1°K, but above this point a striking temperature dependence is reported. Various theoretical models proposed to account for this phenomenon around 1°K are discussed, and are found to be unsatisfactory at higher temperatures. (auth)

15490 FLOW OF SUPERFLUID HELIUM IN A POROUS MEDIUM. Mehl, J. B.; Zimmermann, W. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 167: 214-29(Mar. 5, 1968). (COO-1569-12).

Flow of superfluid liquid helium has been studied experimentally in a porous medium formed by packing fine powder into a hollow glass sphere. The experiments fall into two categories, (1) the study of torsional oscillations of such a sphere filled with helium II as a function of temperature, and (2) the study of persistent circulating flow of the superfluid in such a sphere as a function of temperature and angular velocity of preparation, using a gyroscopic technique. The results at low angular velocities are shown to be in accord with an analysis of the motion of the liquid based on the two-fluid model of helium II and indicate that the superfluid can exhibit dissipationless potential flow in a porous medium with circulation constants which are remarkably stable. (auth)

15491 VORTICITY IN LIQUID He II FLOW THROUGH ORIFICES. Careri, G.; Cerdonio, M.; Dupre, F. (Univ., Rome). Phys. Rev., 167: 233(Mar. 5, 1968).

Recent experiments in wide channels have shown a marked difference between the critical velocity observed in pure superfluid flow and thermal counterflow; because of the lack of a satisfactory hydrodynamical theory, the reason for this difference remains obscure. The onset of superfluid vorticity was investigated for these two types of flow through small orifices of some tenths of a millimeter ID, by means of the technique of trapping of negative ions. The results show that the same difference is also observed in a much simpler geometry; namely, the same paradox already found in channels, that is the law $v_{s,c}d$ = const, expected to hold in pure superfluid flow, is instead followed only in the thermal counterflow, and the effect is geometry-independent. (auth)

15492 THEORY OF PHASE SEPARATION IN SOLID ^{3}He–^{4}He MIXTURES. Mullin, William J. (Univ. of Minnesota, Minneapolis. Univ. of Massachusetts, Amherst). Phys. Rev. Lett., 20: 254-7(Feb. 5, 1968).

It was found earlier that upon cooling, a solution of solid ^{3}He and ^{4}He separates into a ^{3}He-rich phase and a ^{4}He-rich phase. A theoretical analysis of the phase separation is presented here. (M.O.W.)

15493 SOUND PROPAGATION THROUGH A DILUTE SOLUTION OF ^{3}He–^{4}He. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Kuchnir, M. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 251-4(Feb. 5, 1968).

Measurements are reported of both the temperature and frequency dependence of the velocity of sound propagated through a 5.5 mole % solution of ^{3}He in ^{4}He. Attenuation measurements are also presented. (M.O.W.)

15494 ELECTRIC FIELD SUPPRESSION OF THE LAMBDA POINT IN LIQUID HELIUM. Notarys, H. A. (Ford Scientific Lab., Newport Beach, Calif.). Phys. Rev. Lett., 20: 258-9 (Feb. 5, 1968).

Measurements were made of the flow of superfluid helium between liquid reservoirs as an electric field was applied along the poles. It was found that near the superfluid transition temperature T_λ that the flow was decreased by the presence of the electric field. Furthermore, sufficiently close to T_λ it was possible to completely stop the superfluid flow. (M.O.W.)

15495 THIN FILM WINDOWS FOR LIQUID HYDROGEN CONTAINMENT. Wigan, M. R. (Oxford Univ.); Martin, P. M.; Wood, E. Nucl. Instrum. Methods, 59: 61-3(Feb. 1968).

Several methods are described for the containment of cryogenic liquids behind demountable thin (~0.005 cm) plastic windows. Tests were made using liquid hydrogen. (auth)

15496 SUPERCONDUCTING MAGNETS. Chester, P. F. (Electricity Council Research Center, Capenhurst, Eng.). Rep. Progr. Phys., 30: 561-614(1967).

The properties of practical "high-field" superconductors are outlined and related to the theory of type-II superconductors. Their unexpected and disappointing behavior when first wound into coils for the production of high fields is described. This problem is shown to arise from the nature of the current distribution in such materials, and the consequent dissipation under conditions of changing current. The factors affecting this dissipation, and the thermal stability of the materials, are discussed, together with means for achieving stable operation—in particular the use of composite conductors. Some of the engineering problems associated with the further development of large superconducting magnets are outlined—for example, protection against burnout, the support of the large forces developed, and the introduction of current to the magnet. A brief description of some currently planned superconducting magnets, their applications and their economics is given. (auth) (UK)

15497 SUPERCONDUCTIVITY OF VANADIUM–NIOBIUM ALLOYS. Sirota, N. N.; Ovseychuk, E. A. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat Navuk, No. 1, 131(1967). (In Russian).

The critical temperature of transition to superconductivity of vanadium–niobium alloys containing 0 to 100 at. % vanadium or niobium at 10 at. % intervals has been determined by various methods of physicomechanical analysis. It was found that the alloys have superconductivity properties at temperatures ranging from 3.83 to 9.2°K depending upon the at. % of the alloy. (ATD)

15498 SUPERCONDUCTIVITY AND ITS USE IN ENGINEERING. Slavskii, V. V.; Pavlov, P. P. Morsk. Sb. No. 5, 68-73 (1966). (In Russian).

Those areas in which superconductors have received recognition by having been put to practical use, and which can be used in shipbuilding, are discussed in detail. Certain of these areas are frictionless end bearings, superconducting power transformers, superconductive electrical generators and motors, and electromagnetic propellers. The burgeoning development of research in this field makes possible the suggestion that present obstacles will be resolved successfully, and that the time is not far off when various types of superconducting devices will find widespread application in many branches of engineering. (ATD)

15499 DEPENDENCE OF THE ENERGY GAP IN TIN FILMS ON MAGNETIC FIELD AND FILM THICKNESS BY ELECTRON TUNNELING. Shigi, Toyoichiro (Osaka City Univ.); Uchiho, Kousuke; Nakaya, Shigehisa. J. Phys. Soc. Jap., 24: 82-91(Jan. 1968).

By the electron-tunnelling technique, the energy gap 2Δ in superconducting tin films with various thickness d ranging from 3670 to 420 Å was measured as a function of temperature T and magnetic field H parallel to the plane of the tin film. Temperature dependence of 2Δ is almost the same for all tin films and the mean value of $2\Delta(0)/kT_c$ is 3.57, where $2\Delta(0)$ means the energy gap at 0°K. As for the behaviors in magnetic fields, i.e., H dependence of 2Δ and thickness dependence of the critical field determined from 2Δ–H curves, there are marked differences among the films d > 1900 Å, 1900 Å > d > ca. 700 Å and d < ca. 700 Å. Those of the films thicker than 1900 Å agree with the local theories by Ginzburg–Landau–Gor'kov–Douglass and Ginzburg–Landau, respectively, while those of the films with medium thickness, 1900 Å > d > ca. 700 Å, are consistent with the nonlocal theories by Casella–Miller or Nambu–Tuan qualitatively. However for the thickness region d < ca. 700 Å there is no theory to explain the experimental results in the magnetic field, but if type-II superconductivity is assumed for these very thin films, a reasonable explanation can be given. (auth)

15500 SOME PECULIARITIES OF THE SYNCHRONOUS MACHINE WITH SUPERCONDUCTING FIELD WINDING. Treshchev, I. I. Elektrichestvo, No. 2, 42-6(1967). (In Russian).

A synchronous machine with a steel magnetic circuit and an "infrozen" magnetic flux (in other words, with a superconducting field winding) is considered. In the 3-phase short-circuit case, the sustained armature and field currents will exceed those of the conventional machine by a factor of x_d/x'_d; this fact essentially modifies other characteristics of the superconducting machine (SCM). After clearing a short-circuit, the voltage recovery in the SCM occurs immediately; hence, no quick-response field forcing is necessary. The strong voltage self-regulation of the SCM will make regulation equipment smaller and lighter. High static and dynamic stability of the SCM permits reducing its short-circuit ratio, airgap, and size. Despite the above good dynamic characteristics, SCM's are hardly practical at the present time because of problems associated with cryogenic techniques and superconducting materials. (ATD)

15501 LOW-TEMPERATURE REFRIGERATION FOR MICROWAVE SYSTEMS. A Technical Colloquium, held in Frankfurt am Main, West Germany, April 28–29, 1966. Hogan, Walter H.; Klipping, Gustav (eds.). Cambridge, Mass., Boston Technical Publishers, Inc., 1967. 290p. $19.50. (CONF-660462).

Papers given deal with the design of parametric amplifiers and masers, their developmental problems, their integration into operational systems, and their interface with cryogenics. Other papers deal with the design of cryogenic equipment, the state-of-the-ore, and the problems of their development. (W.D.M.)

15502 SUPERCONDUCTING CABLE. (to United States Atomic Energy Commission). British Patent 1,101,617. Jan. 31, 1968. Priority date Oct. 29, 1964, United States.

The cable described is comprised of six 10-mil hard superconductors (Nb–25 wt % Zr) with aluminum coatings (0.1 by 0.06 in.); the wires are spatially mounted with respect to each other in a rectangular configuration. With this arrangement the following currents were obtainable: with a 10-kG center of field, 60 amperes per conductor; with a 35-kG field, 40 amperes per conductor. (TSS)

Plasma and Thermonuclear Physics

15503 (AED-C-03-15) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX. VOLUME 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec. 1967. 214p. Dep.

A listing is given of 372 articles on various aspects of plasma physics. Author and subject indexes are included. (M.O.W.)

15504 COLLECTED PAPERS OF L. D. LANDAU. Ter Haar, D. (ed.). New York, Gordon and Breach, Science Publishers, 1967. 855p. $32.00.

Approximately 100 papers written by Landau are included. The papers deal with the following subject areas: (1) Low-temperature physics, (2) solid-state physics, (3) plasma physics, (4) hydrodynamics, (5) astrophysics, (6) nuclear physics and cosmic rays, (7) quantum mechanics, (8) quantum field theory, and (9) miscellaneous. (M.O.W.)

Confinement and Heating of Plasma

15505 (IIF-LA-4) IMPUL'SNAYA TERMOYADERNAYA SISTEMA S PLOTNOI PLAZMOI. (Pulsed Thermonuclear System with Dense Plasma). Alikhanov, S. G.; Kichigin, G. N.; Konkashbaev, I. K. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1967. 13p. (In Russian). Dep.

The closed system, favorable for the adiabatic compression of dense plasma by means of the deformation of the container is examined. It is shown that, during a requisite time, the system attains equilibrium and magnetohydrodynamic stability. An adequate compression rate and a short operating time makes it possible to neglect the comparatively slow loss of plasma as a result of diffusion. (tr-auth)

15506 (UCID-15265) UPPER LIMIT OF ELECTRON LOSSES DURING E-LAYER BUILDUP. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 24, 1968. Contract W-7405-eng-48. 17p. Dep. CFSTI.

The interaction of newly injected electron pulses with the electrons previously trapped in the E layer is examined, and the upper limit of loss of trapped electrons caused by this interaction is calculated. (M.O.W.)

15507 (UCRL-Trans-10223) INVESTIGATION INTO THE FILLING OF A TOROIDAL MAGNETIC CONFIGURATION BY THE INJECTION OF FAST NEUTRALS. Fumelli, M.; Girard, J. P.; Gourdon, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by W. Robinson for Univ. of California Lawrence Radiation Lab., Livermore, from report EUR-CEA-FC-432. 49p. Dep. CFSTI. JCL $4.60 fs, $1.70 mf.

The investigation shows the possibility of forming in a toroidal configuration a plasma of density greater than $10^{12}cm^{-3}$ and of a high temperature (greater than 500 eV for the special conditions of the calculation). It is further shown that if fast neutrals are injected into a pre-established plasma ($n_i \sim 10^{10}cm^{-3}$; $T_e \sim 2$ eV) one can obtain in less than 1 second a density greater than $10^{12}cm^{-3}$ and a temperature of 40 eV, and this with a diffusion time only 100 times greater than the Bohm diffusion time. (M.O.W.)

15508 NONADIABATIC INJECTION OF PLASMA INTO A STELLARATOR WITH A DOUBLE-HELIX-TYPE MAGNETIC FIELD. Fedyanin, O. I.; Khol'nov, Yu. V.; Zubkov, V. L. Zh. Tekh. Fiz., 37: 1797-1807(Oct. 1967). (In Russian).

In an earlier paper one of the authors (O. I. Fedyanin, At. Energ. (USSR), 18: 329(1965)) showed that effective trapping of plasma may occur incident to injection of plasma into a linear system in a magnetic field with space and time modulation. The plasma forms a long-lived filament, which is localized at a distance from the chamber walls. The present report describes the results of similar experiments involving injection of plasma into a toroidal magnetic trap with a double-helix type magnetic field. A photograph of the setup shows the donut chamber mounted in the double-helix magnetic field, which is produced by an array of 32 coils and a helical winding (two pairs of ribbon conductors). The field configuration is briefly described. The experimental results are discussed at some length. Injection of plasma into a toroidal trap of the given type is an unsteady process during the filling of the trap. For purposes of evaluating the filling time it is assumed that (1) the trap is a closed system only in the sense of periodic motion of the particles, (2) the injector represents a transparent surface emitting particles along the axis in both senses of the toroid, and (3) the plasma is "created" at t = 0 and is characterized by an initial distribution that is closely described by a simple analytic function. It is concluded that injection from outside is a feasible procedure for filling the chamber of an L-2 Stellarator. The plasma injected into the trap by the method of a programmed magnetic field effectively fills the trap within a time that is determined by the velocity dispersion of the directed plasma flux and the geometry of the system ($t \alpha L/\Delta v$). The proposed technique is reasonably efficient as regards trapping. The experimental results indicate that the injection conditions exert a significant influence on the plasma distribution in the Stellarator over a period of the order of hundreds of microseconds. (ATD)

15509 EXPERIMENTS ON NONADIABATIC TRAPPING OF HIGH-ENERGY HYDROGEN IONS IN A MAGNETIC MIRROR MACHINE. Ozaki, Norihiko; Kenmochi, Masashi; Dodo, Taro (Hitachi Ltd., Tokyo). J. Phys. Soc. Jap., 24: 595-603(Mar. 1968).

Ion cyclotron resonance heating and nonadiabatic trapping of the hydrogen ions are investigated using a magnetic mirror machine with a mirror ratio of 2. A high-energy (150 to 450 eV) and low-intensity (500-μA) hydrogen ion beam is injected along the magnetic lines of force and subjected to ion cyclotron resonance heating by a constant frequency (4.5 Mc) rf electric field at the midplane of the magnetic mirrors. Nonadiabatic trapping of the atomic and the molecular ions is observed distinctly. More than 50% of the injected atomic and molecular ions are reflected by the mirror field, the reflected ions having energies of 300 to 900 eV. (auth)

15510 COMPRESSION OF A PLASMA BY A MAGNETIC FIELD. Anderson, N. Int. J. Electron., 22: 387-8(Apr. 1967).

In a previous paper (Int. J. Electronics, 18: 473(1965)) the author set up a model to investigate the linear problem of heating in a cylindrical column of plasma by means of an oscillating magnetic field. In this note, the nonlinear problem is considered, indicating that this mechanism for heating a plasma could be successful. (UK)

15511 EXPERIMENT OF LINEAR TURBULENT HEATING OF PLASMA. Matsukawa, Yoshinobu; Nakagawa, Yoshiro; Watanabe, Kenji (Osaka City Univ.). J. Phys. Soc. Jap., 24: 196-200(Jan. 1968).

Characteristics of the linear turbulent heating are experimentally studied. A hydrogen plasma of density of 1×10^{13} ions/cc and electron temperature of 9.5 eV was injected into a metal tube in a magnetic mirror field, and through the fully ionized plasma a discharge was successively made along the magnetic field lines with the turbulent heating. The diamagnetic measurement shows heated pressures of 1.7×10^{16} eV/cc, and the hard x rays of 20 to 70 keV energies are observed to last for 200-μsec duration. The detection of hard x rays was found to be very sensitive to the operating condition of the plasma source. As the ignition energies of the plasma source decrease, the energies of hard x rays increase and the observed duration of them increases up to 500 μsec. (auth)

15512 EXPERIMENTS ON CYCLOTRON RESONANCE AND NONADIABATIC TRAPPING OF HYDROGEN IONS IN A MIRROR MACHINE. Dodo, Taro (Hitachi Ltd., Tokyo); Ozaki, Norihiko; Kenmochi, Masashi; Nagao, Shigeo; Sugita, Keiichiro. J. Phys. Soc. Jap., 24: 383-91(Feb. 1968).

Ion cyclotron resonance and nonadiabatic trapping of the hydrogen ions in a mirror machine are investigated. A hydrogen plasma (about 10^8 ions/cm^3) diffuses into a magnetic mirror field along the magnetic lines of force and an rf electric field of 4.5 Mc is applied to the plasma through a pair of plane electrodes at the midplane of the magnetic mirrors. It is observed that the magnetic moments of the ions are increased nonadiabatically at cyclotron resonance field for the molecular ions (5.8 kG) and the atomic ions (2.9 kG). The latter is attributed to the harmonic resonance of the molecular ions. Nonadiabatic trapping of the molecular ions in a mirror field is also observed at 5.8 and 2.9 kG. About 15% of the injected ions is reflected from the far mirror field. The most of the ions escape through the far mirror field because the applied rf electric field is shielded by the plasma. (auth)

Diagnostics of Plasma

15513 (SC-DC-67-2052) EXPERIMENTAL STUDY OF ELECTRICAL CURRENTS TO A FLAT PLATE IN A FLOWING, WEAKLY IONIZED GAS. Burke, A. F. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Sept. 1967. Contract AT(29-1)-789. 15p. (CONF-680101-3). Dep. CFSTI.

From AIAA 6th Aerospace Sciences Meeting, New York.

An experimental study of electrical currents to a flat plate in a flowing plasma was conducted using the gas behind the incident shock in a shock tube as the test medium. Theoretical comparisons were made with the data. (M.O.W.)

15514 MEASUREMENT OF PARAMETERS OF A THETA PINCH IN AN AZIMUTHAL MAGNETIC FIELD. Volkov, Ya. F.; Dyatlov, V. G.; Mitina, N. I. Zh. Tekh. Fiz., 37: 1792-6(Oct. 1967). (In Russian).

Plasma densities and electron temperatures were measured in theta pinches in helium plasmas at pressures from about 0.05 to 0.2 mm Hg in the presence and absence of an azimuthal magnetic field produced by discharge of a capacitor through an axial conductor. The plasma densities were determined from the Stark broadening of the 4686 Å line of He II and were confirmed by probe measurements. The electron temperatures were determined from the intensity ratio of the 5016 and 5876 Å He lines and from the absorption in aluminum of the soft x rays produced by the electrons striking the axial conductor. Some of the results are presented graphically and are discussed briefly and compared with earlier results at lower pressures. Application of the azimuthal magnetic field increased the plasma density at pressures above 0.05 mm Hg. With increasing pressure above about 0.01 mm Hg the electron temperature for a given azimuthal magnetic field decreased. At pressures below 0.01 mm Hg the electron temperature increased with increasing strength of the azimuthal magnetic field. Electron temperatures up to about 4.5 keV were recorded. (ATD)

15515 MEASUREMENT BY INFRARED LASER INTERFEROMETRY OF THE ELECTRON DENSITY IN PLASMAS PRODUCED IN SHOCK TUBES. Fontaine, Bernard; Inglesakis, Georges; Valensi, Jacques (Institut de Mecanique des Fluides, Marseille). Compt. Rend., Ser. A and B, 265: 1230-3(Nov. 27, 1967). (In French).

The measurement of the electron density by laser interferometry in the infrared made it possible to estimate the ionization relaxation time behind the shock wave. This estimation agrees very well with previous results for high-impurity rates. The measurement of the electron density at equilibrium shows a good agreement between the values obtained using the Rankine–Hugoniot relations and experiments. The measurement of the deionization profile was made at equilibrium. The results show a certain disagreement with the theoretical curve. (J.S.R.)

15516 MEASURING THE TEMPERATURE OF A PLASMA JET. Berty, Michel (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Paris). Entropie, 23-36 (July-Aug. 1966). (In French).

A spectrographic method was used for the measurement of temperature in plasma jets at atmospheric pressure by use of the amplification of the Hβ line of hydrogen. Following exposition of the principle and of the application of the measurement method, the experimental conditions and the results obtained in argon–hydrogen plasmas and in hydrogen alone at 10 to 25 kW are described. (IAA)

Kinetics of Plasma

15517 (GA-8074) DRIFT WAVE TRANSMISSION IN A MAGNETIC QUADRUPOLE CONFIGURATION. Voorhies, H. G.; Ohkawa, T. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 26, 1967. 12p. (CONF-670810-7).

From 8th International Conference on Phenomena in Ionized Gases, Vienna, Austria.

A dispersion relation is measured for a drift wave launched in a low-density, low-temperature plasma confined in a magnetic quadrupole configuration. Transmission is only possible in a region with density gradient near a current-carrying ring and in the direction of the diamagnetic current. The experimental results are compared with a theoretical dispersion relation. (auth)

15518 (IIF-LA-6) OB USLOVIYAKH PRIMENIMOSTI PRIBLIZHENIYA KHAOTICHESKIKH FAZ DLYA NELINEINOGO VZAIMODEISTVIYA VOLN V PLAZME. (Applicability of Random Phase Approximation for Nonlinear Wave Interactions in Plasma). Zaslavskii, G. M. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 10p. (In Russian). Dep.

The dynamic equations describing the nonlinear interaction of small-amplitude waves in plasma with discrete spectra were examined. The conditions under which the random phase approximation was correct were obtained. The criterion depends on the form of the spectrum, the wave amplitude, and the distance between harmonics in the spectrum. It is shown that in the limiting case of a continuous spectrum, the random phase criterion was reached automatically. The boundary of the wave spectrum for which the kinetic equations are applicable is given. (tr-auth)

15519 (LA-tr-68-7) OSCILLATIONS OF PLASMA AND STRIATIONS. Gordaev, V. Translated for Los Alamos Scientific Lab., N. Mex., from Zh. Eksp. Teor. Fiz., 22: 230-40 (1952). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Striations, which are considered as a group of waves, are treated theoretically. Comparison of theory with experiment is discussed. (auth)

15520 RATE OF IONIZATION AND DISTRIBUTION OF ATOMS OVER EXCITED STATES IN A WEAKLY IONIZED PLASMA. Sonin, E. B. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 37: 1840-51(Oct. 1967). (In Russian).

An electronic computer was used to calculate the rate of ionization (effective ionization cross section) and the populations of excited atomic states under steady state conditions in a locally uniform weakly ionized cesium plasma. Inelastic electron-atom collisions and recombination in three-body collisions were taken into account in the calculations, but radiative transitions were neglected. The calculations were first performed on the assumption that the electrons have a Maxwell distribution and with the 40 lowest excited states of the cesium atom taken into account, the higher excited states being ignored. Similar calculations were performed with fewer excited states taken directly into account and the higher excited states assumed to be in equilibrium with the continuum. A comparison of the results indicated that the higher excited states are far from thermodynamic equilibrium and suggested that even 40 excited states might be too few to give reliable results. A further calculation in which all the levels up to the 29P level lying 0.02 eV below the continuum were included, however, gave results only slightly different from those obtained when only the 40 lowest levels were included. An expansion and moment technique developed earlier by the author was employed to calculate in a linear approximation the deviation of the electron distribution function from the Maxwellian form, and it is concluded that the nonequilibrium ionization does not lead to significant deviation of the electron distribution function from the Maxwellian form in a locally uniform plasma. There is an appendix describing the Monte Carlo calculation of the coefficients employed in these calculations to describe the electron–electron interactions. The range of validity of the linear approximation employed in these calculations is discussed. (ATD)

15521 EXCITATION OF IONIC–ACOUSTIC INSTABILITY IN THE FIELD OF A STRONG ELECTROMAGNETIC WAVE. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Zh. Tekh. Fiz., 37: 1789-91(Oct. 1967). (In Russian).

The stability of a plasma in which the electron temperature greatly exceeds the ion temperature is described with respect to excitation of ionic sound waves by an electromagnetic wave of finite amplitude traversing the plasma. The change in the time average of the electron velocity distribution function due to the presence of a plane monochromatic electromagnetic wave of finite amplitude is first calculated. It is found that the wave communicates to the electrons an average velocity in the direction of the wave propagation proportional to the square of the wave amplitude. This average electron distribution function is employed in place of the usual Maxwell distribution as the unperturbed electron distribution function in the kinetic equations with self-consistent field, and the corresponding dispersion equation is derived. It is found that under certain conditions the ionic sound oscillations will be unstable (i.e., will grow) provided the amplitude of the electromagnetic wave exceeds a certain value, which is given. (ATD)

15522 RESONANCE INTERACTION OF PARTICLES WITH WAVES OF THE ALFVEN TYPE IN A NONUNIFORM FINITE-PRESSURE PLASMA. Mikhailovskii, A. B.; Fridman, A. M. (Novosibirsk State Univ., USSR). Zh. Tekh. Fiz., 37: 1782-8 (Oct. 1967). (In Russian).

In earlier work it was shown that there are two types of oscillations of a nonuniform finite-pressure plasma with frequencies much lower than the ion cyclotron frequency and wavelengths much longer than the ion Larmor radius, namely ionic sound waves and Alfven-type waves; that the ionic sound waves are damped by strong resonance interaction with the plasma particles; and that in the first approximation (to the zeroth order in $(kR)^2$, where k is the wave vector and R is the ion Larmor radius) there is no resonance interaction between the plasma particles and the Alfven waves. In the present paper the authors discuss the Alfven waves in the second approximation (the first order in $(kR)^2$) and show that resonance interaction with the plasma particles can, depending on the conditions, either damp the Alfven waves or lead to their growth. The corresponding conditions are derived and formulas are obtained for the damping and growth constants. When the frequency is greater than $k_z V$ (K_z is the component of the wave vector in the direction of the magnetic field and V is the thermal velocity of the ions) the waves are damped for practically all values of the temperature gradient ndT/Tdn (T is the ion temperature and n is the plasma density). If the magnetic field is weak, there are waves with frequencies lower than $k_z V$ only when the temperature gradient lies within a narrow range. If the magnetic field is strong,

however, the low frequency waves exist for all temperature gradients, and if the temperature gradient is negative their amplitude can be increased by resonance interaction with the plasma particles, leading to instability of the plasma. (ATD)

15523 NONLINEAR IONIC CYCLOTRON OSCILLATIONS OF A PLASMA. Petviashvili, V. I. Zh. Tekh. Fiz., 37: 1763-7(Oct. 1967). (In Russian).

Ionic cyclotron waves of finite amplitude in an infinite uniform plasma are discussed. The plasma ions are assumed to be cold, and their motion is treated in the hydrodynamic approximation. It is assumed that the magnetic pressure is much higher than the kinetic pressure, that the oscillation frequency, which is of the order of the ionic cyclotron frequency, is much lower than the ionic plasma frequency, and that the phase velocity of the waves is much lower than the thermal velocity of the electrons. There is derived a pair of nonlinear equations, analogous to a dispersion equation and reducing in the linear approximation to the usual dispersion equation for ionic cyclotron waves, relating the wavelength, frequency, and energy of the oscillations and the strength of the electric field accompanying them. In the linear approximation the electric field vanishes in the rest system of the ions, but in the nonlinear case (finite wave amplitude) it does not, and there is a flux of electromagnetic energy in the direction opposite to the propagation direction of the waves. The two branches (fast and slow) of the ionic cyclotron oscillations are found to behave differently when their amplitudes are increased; the fast waves are strongly absorbed with resultant heating of the ions when their amplitude exceeds a critical value, owing to the appearance of the ionic cyclotron resonance, whereas the slow waves do not lead to resonance and are not strongly absorbed. It is concluded that there is a finite upper bound to the energy density of ionic cyclotron waves; the amplitude of the fast waves is limited by absorption, whereas that of the slow waves is limited by a nondissipative process that does not involve heating of the plasma ions. (ATD)

15524 NOTE ON THE DISPERSION RELATION FOR VERY HIGH TEMPERATURE PLASMA. Majumdar, Saroj K. (Saha Inst. of Nuclear Physics, Calcutta). Indian J. Phys., 41: 507-10 (July 1967).

The asymptotic expansion of the function $S_\nu(z)$ which completely describes the plasma dispersion law and introduced by Majumar (1965) has been carried out for very high temperature and low magnetic field. From this expression the well-known results of zero magnetic field case are recovered. (auth)

15525 STATE OF HIGH-TEMPERATURE PHYSICS. Euler, K. Joachim. Chem.-Ing.-Tech., 40: 21-8(Jan. 19, 1968). (In German).

The field of high-temperature physics is characterized by the study of the properties of materials at temperatures above 5000°K. Ionized gases or plasmas are characteristic states in this temperature region. Pinched arcs, exploding wires, and high-voltage surges are possibilities for the generation of high temperatures. The use of welding arcs, plasma guns, and arc furnaces is discussed. High-temperature physics is making an important contribution to research work on MHD generators and fusion reactors. (auth)

15526 ELECTRICAL dc CONDUCTIVITY OF A TURBULENT PLASMA. Shimahara, Hiroko; Kiyama, Satoru; Ogawa, Kiyoshi; Kato, Kiyoe (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 24: 604-10(Mar. 1968).

The variation of the electrical dc conductivity of a turbulent plasma from a quiescent plasma is observed. The turbulent plasma is produced by applying an external rf voltage to the quiescent uniform plasma. When the external rf frequency is near the electron plasma frequency f_{pe}, the decrease of the electrical dc conductivity is observed (30% maximum). The decrease is proportional to the square of the external rf voltage and the saturation occurs beyond a certain level of the rf voltage. The decrease of the electrical dc conductivity depends largely on the direction of the externally applied rf field with reference to that of the dc current. (auth)

15527 STUDY OF THE PRESSURE AND TEMPERATURE DEPENDENCE OF ELECTRON-ION RECOMBINATION IN NEON. Kasner, W. H. (Westinghouse Research Labs., Pittsburgh). Phys. Rev., 167: 148-51(Mar. 5, 1968).

Conventional microwave and mass-spectrometric techniques have been used to study the loss rate of electrons and ions in the afterglow following microwave discharges in neon. Under the conditions of the experiment, the afterglow decay rate is controlled by the recombination of electrons with the only observed ion species, Ne_2^+, yielding a recombination coefficient which has a value of $\alpha(Ne_2^+) = (1.8 \pm 0.2) \times 10^{-7}$ cm^3/sec at 295°K and a temperature dependence of $T_e^{-0.42 \pm 0.04}$ over the range covered, 295 to 503°K. At any given temperature, the measured recombination rates show no systematic dependence on the neon gas pressure over the range used, 8 to 30 torr, indicating that the observed recombination process is a two-body reaction. Temporal mass analysis shows similar decay rates for the Ne_2^+ ions and for the electrons over the major portion of the afterglow. (auth)

15528 TIME-DEPENDENT STUDY OF THE EMITTED LIGHT AND ELECTRON DENSITY IN A LOW-PRESSURE HELIUM AFTERGLOW. Collins, C. B.; Hurt, W. B. (Southwest Center for Advanced Studies, Dallas). Phys. Rev., 167: 166-70(Mar. 5, 1968).

The relation between the emitted light and decay of electron density in a pulsed helium afterglow at 1 torr has been studied using a 0.75-meter tandem monochromator and 36-Gc microwave interferometer. Substantial signal-to-noise enhancement was obtained with an automatic data-processing system enabling populations of the n^3D levels ($n \leq 25$) to be measured as a function of time to 10 msec in the afterglow. In addition, the populations of low quantum levels and the free-electron concentration were measured to 20 msec. It was found that the time-dependent behavior of the levels divided them naturally into three groups, only the lowest-lying of which had been measured in previous afterglow experiments. The levels of this lowest group were found to decay exponentially with the same lifetime for better than three orders of magnitude. Levels of the middle group were found to decay exponentially for 2.5 decades, the lifetimes increasing monotonically with quantum number. Levels of the third group were identified to be in Saha equilibrium with the free electrons, and uniformly had lifetimes equal to the sum of the calculated atomic and experimentally measured electron lifetimes. (auth)

15529 GREEN'S FUNCTIONS FOR COULOMB SYSTEMS WITH COLLISIONS. Mel'nikov, V. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 3, 44-54(May-June 1967). (In Russian).

Equations are obtained for Green's functions. Lenard's nuclear equations are integrated and their relation to the Landau kernel used in further calculations is found. The successive approximation method is used in order to find Green's functions in E and K space and the natural frequency and attenuation of the system, taking into account the spatial dispersion. (tr-auth)

15530 EDGE CONDITION AND "INTRINSIC LOSS" IN UNIAXIAL PLASMA. Lee, S. W.; Mittra, R. (Univ. of Illinois, Urbana). Can J. Phys., 46: 111-20(Jan. 15, 1968).

The electromagnetic field behavior near the edge of a conducting wedge in contact with a uniaxial plasma was investigated. The static magnetic field in the plasma was assumed to be perpendicular to the edge. Explicit expressions are obtained for the eigenvalue t which governs the edge behavior. The nonresonance case is treated first and the results are extended subsequently to the resonance case via analytic continuation of the functions involved, using a three-sheeted Riemann surface. The behavior of t is found to be distinctly different in the resonance case from either the isotropic or the nonresonance case in that singularities at the edge now occur for a certain range of the external angle of the conducting wedge, less than π. It is also found that "intrinsic losses" may occur for certain parameters in a purely lossless resonance plasma. However, the degenerate surface wave discussed by earlier workers does not accompany the intrinsic-loss phenomenon as it does for a parallel orientation of the dc magnetic field investigated by the above workers. Consequently, it is no longer possible to explain the intrinsic loss in terms of energy transported by the degenerate surface wave. A possible resolution of this difficulty is suggested for an ideally lossless medium via the derivation of a mathematical solution which does not display any intrinsic losses, and hence, satisfies the energy condition in such a system. The slightly lossy case is examined in detail and it is shown that in the presence of some loss in the medium, however slight, large energy losses are expected to occur in the neighborhood of the edge. Nevertheless, these losses are explainable and should not be regarded as "intrinsic." (auth) (Canada)

15531 SCATTERING OF ELECTROMAGNETIC WAVES ON PLASMA WAVES. Filippov, G. M. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 3, 15-22(May-June 1967). (In Russian).

The scattering of weak electromagnetic waves off plasma waves in an unbounded anisotropic plasma is analyzed. The electromagnetic wave propagation is assumed to be along the direction of the plasma waves. The analysis is carried out using the nonlinear Vlasov equation. (TSS) (ATD)

15532 ON THE FLOW OF CHARGED PARTICLES TO CATHODE IN PENNING-TYPE DISCHARGE IN HIGH VACUUM. Smirnitskaya, G. V.; Babertsyan, R. P. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 3, 23-9(May-June 1967). (In Russian).

Ion currents were investigated in cold cathodes of the Penning type using a collector which consisted of isolated concentric rings placed behind one of the cathodes with a small hole in the center. The results are plotted as discharge current and radial ion current density curves versus the magnetic field, which varied from 200 to 900 oersteds. Results were also obtained showing the drop in ion current density as a function of the ion beam energy. Similar studies were made for the electron current flowing through the cathode opening onto a Faraday cylinder placed behind the cathode. The experiments were performed at low pressures and in strong magnetic fields. For H = 1000 oersteds and $p = 10^{-4}$ torr, the electron energies reached a peak value of 70 eV. Curves are also shown for discharge current as a function of the anode potential V_a. Increasing V_a increases the radial component of the electron velocities as well as the discharge current. (ATD)

15533 LONGITUDINAL PLASMA FLOWS IN AN AC ELECTRIC ARC. Bron, O. B.; Sushkov, L. K. Elektrotekhnika, No. 5, 28-31(1967). (In Russian).

Plasma flows are observed emanating from sections of a heavy-current electric arc in which changes of the arc's cross section occur. The basic cause of this phenomenon can be found in the pressure differences arising at various points of the arc which are set apart from each other under the action of the arc's own magnetic field. Investigation of this phenomenon was made at 50 Hz with an ac current of up to 1000 A and 450 to 500 V in a network with an active load. The distance between the copper and coal electrodes was 3 to 60 mm. The following conclusions were made on the basis of experiments: Longitudinal plasma flows arise in regular arc points as well as in places of artificial reduction of arc diameter. These flows continue to exist and move for a certain time after the current passes through zero. As new plasma flows arise, they superimpose the afterglow regions of the preceding half-periods. The new plasma flows do not arise immediately after the current passes through zero. As new plasma flows arise, they superimpose the afterglow regions of the preceding half-periods. The new plasma flows do not arise immediately after the current passes through zero. Under the effect of plasma flows the arc takes on a shape depending on the current phase and the distribution of electrodes. These plasma flows also influence the amount of voltage necessary for burning of the arc. With dc they stimulate steady burning; with ac, they fill the interelectrode space and help repeated firing. By contrast, when the plasma flows are in such a direction that energy is removed from the interelectrode space, they hamper steady burning and raise the value of the firing voltage. (ATD)

15534 LONGITUDINAL PLASMA FLOWS IN AN ELECTRIC ARC. Bron, O. B.; Sushkov, L. K. Elektrotekhnika, No. 12, 1-5(1966). (In Russian).

An experimental investigation was made of plasma flows at electrodes and in artificially made constrictions. Dc arcs with currents of 30 to 200 A and interelectrode spacings of 30 to 100 mm were investigated; the electrodes were made from carbon, copper, brass, and steel; their shapes and arrangements were varied. Plasma flows were filmed by a rapid motion-picture camera (200 to 1200 frames per sec); typical pictures are shown. Arc duration was 0.02 to 0.1 sec. It was found that: (1) longitudinal plasma flows have high conductivity, and when they are not continuous, the arc plays not between the electrodes but rather between the plasma flows; (2) artificial arc constriction (diaphragm with a hole) creates local plasma flows; (3) in all observed cases, the longitudinal plasma flows were perpendicular to the emitting surfaces unless influenced by an external factor; and (4) plasma flows have a shape of narrow well-defined beams, testifying to their electromagnetic origin. The above results may be used for designing arc-suppressing devices. (ATD)

15535 CYLINDRICAL WAVES IN A DILUTED PLASMA IN PRESENCE OF STRONG COLLISIONLESS DISSIPATION. Berezin, Yu. A.; Kurtmullaev, R. Kh. Fiz. Goreniya Vzryva, No. 3, 3-11(1966). (In Russian).

A study of collisionless shocks propagating in laboratory plasmas is reported. A cylindrical symmetric two-fluid system subjected to externally applied magnetic fields varying sinusoidally is considered theoretically. The numerical solutions obtained for the magnetic field distribution in the plasma at various times show that this model is sufficient to account for the experimentally observed field structure if an arbitrary constant dissipation is assumed. This work allows one to establish regions in which the wave is formed, becomes quasistationary and changes over to a flow with rapidly increasing field near the plasma axis. It is also shown that the magnetic piston behind the wave front determines the behavior of the wave, influencing strongly the ratio of the magnetic field at a particular phase to that of the plasma density. A table of plasma parameters sufficiently varying is provided, allowing the application of the results of this study to laboratory plasmas that are not collision-dominated. Discussion of the dissipation on the wave structure shows the importance of collective effects which must be assumed to explain experimental results. (ATD)

15536 AUTOIONIZATION PHENOMENON WITH VIOLATION OF INTERCOMBINATION FORBIDDENNESS IN A PLASMA. Grechikhin, L. I. (Inst. of Physics, Moscow). Dokl. Akad. Nauk BSSR, 11: 214-16(1967). (In Russian).

To explain why autoionization can be produced in atoms such as copper or aluminum, for which interaction between doublet and quartet states (intercombination forbiddenness) greatly reduces the autoionization probability, the authors propose that when the excited atom in the quartet state collides with an electron in the plasma, the spin−spin interactions give rise to a state whose wave function is a superposition of all the states corresponding to the given term. This superposition contains states with different spins, and the resultant superposition state decays by a transition to the continuous spectrum (autoionization) or by deactivation upon collision with an electron. The ratio of the intensities of these two processes is estimated and it is found for the case of copper that if the intensity of the autoionization line exceeds that of the nonautoionization line by a factor smaller than 36, then the autoionization is still observable. This ratio can thus be used to determine the concentration of charged particles in a plasma. (ATD)

15537 DISTRIBUTION FUNCTIONS FOR SYSTEMS OF CHARGED PARTICLES TAKING SHORT RANGE FORCES INTO ACCOUNT. Strel'tsova, E. A. Ukr. Mat. Zh., 18: 69-83 (1966). (In Russian).

A general method for the asymptotic solution in statistical mechanics of classical systems allowing the handling of both Coulomb and short-range forces is described. A system of N particles of m different kinds contained in a volume V with a binary potential acting between the particles is considered. The method of Bogolyubov is followed. (TSS) (ATD)

15538 SCATTERING OF ELECTROMAGNETIC WAVES BY A CYLINDRICALLY INHOMOGENEOUS PLASMA. Nozaka, Mitsunobu; Sato, Ginko; Takaku, Koshun (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 24: 172-84(Jan. 1968).

The expressions of the scattering electromagnetic fields are obtained by using the exact solutions of the field equations in the concentric cylindrical media whose propagation coefficients are given by k_0, kr^m and k_1 for a radial distance $r_1 \leq r$, $r_2 < r < r_1$ and $r \leq r_2$ respectively and the medium varies continuously through the boundaries $r = r_i$ (i = 1.2). The notations k_0, k and k_1 are independent of r, and m gives the inhomogeneity of the plasma and by its value the field is very sensibly and complicatedly affected. The normal incident cylindrical and plane electromagnetic waves are assumed to be polarized to perpendicular and parallel to the axis of the plasma column. A calculation by the saddle point method leads to the three types of the rays each of which has a simple form and a clear physical meaning. From the numerical calculations of the field strengths of these rays, many characteristic scattering patterns which are never anticipated from a homogeneous system are obtained for the various electron density profiles of the plasma column. (auth)

15539 LOW-FREQUENCY OSCILLATIONS IN A MAGNETIZED CARBON ARC. Enjoji, Hiroshi; Ishii, Shigeyuki; Okamoto, Kousuke (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 24: 184-96(Jan. 1968).

Low-frequency oscillations (<1 Mc) in a magnetized carbon arc were observed in order to study the oscillation mechanisms in a fully ionized, high-temperature, high-density plasma. The pressure range used is from 10^{-3} to 10^{-5} torr, and the ion and the electron temperature are 2×10^3 and (3 to 11) $\times 10^4$°K, respectively, and the electron number density is about 1×10^{14}/cc. At least four types of oscillations were detected. They are due to acoustic waves, Alfvén waves, drift waves, and I_rB_z plasma rotation. The frequencies of the acoustic waves are 25, 140, 390, 420, and 450 kc, and those of the Alfvén waves, the drift waves, and the I_rB_z plasma rotation are 50, 175, and 280 kc, respectively, at an arc current of 100 A and magnetic field of 2500 gauss. (auth)

15540 HARMONIC COMPONENTS REFLECTED FROM A PLASMA FREE SPACE INTERFACE AROUND PLASMA RESONANCE. Gupta, G. P. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap., 24: 201-3(Jan. 1968).

Expressions for the magnitude of the second and third harmonic components of the electric vector in the reflected wave were ob-

tained for the case of normal incidence of an electromagnetic wave (having a frequency near plasma frequency) on a plasma free space interface. (auth)

15541 EXACT CORRELATION FUNCTION OF ELECTRIC FIELDS IN A ONE-DIMENSIONAL PLASMA. Okutani, Jun-ichi (Tokyo Univ.). J. Phys. Soc. Jap., 24: 401-11(Feb. 1968).

Exact correlation function of electric fields of the ion–electron sheet model is obtained using Lenard's method. The result is an infinite series including the Fourier coefficients of the even Mathieu function of the zeroth order. The spectrum I_k with respect to the wave number k is shown to be proportional k^{-2}. This fact suggests that this model plasma lacks an important nature of plasma—the Debye shielding. The limits in which the plasma parameter tends to zero or infinity are also investigated. (auth)

15542 VOPROSY TEORII PLAZMY. (Problems of Plasma Theory). Leontovich, M. A. (ed.). Moscow, Atomizdat, 1967. 472p.

Five articles are included on plasma physics and controlled nuclear fusion, including plasma stability in magnetic mirror traps, self-contained nuclear reactions in traps, and plasma concentration in the pinch effect. Closed magnetic field configurations for plasma containment are discussed in the first article. The second article handles the turbulent processes in the toroidal system. Anisotropic plasma cyclotron instability is covered in the third article. The last two articles cover the magnetohydrodynamic theory of the pinch effect in a dense high-temperature plasma and the energy balance and problem of self-containing thermonuclear reaction in magnetic mirror traps. Each article includes a list of references. (R.V.J.)

15543 RASPROSTRANENIE ELEKTROMAGNITNYKH VOLN V PLAZME. (Propagation of Electromagnetic Waves in Plasma) Ginzburg, V. L. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1967. 684p.

Propagation of various-frequency electromagneto-active, homogeneous, and inhomogeneous plasma is covered in the first five chapters. Reflection of radio waves from ionospheric layers and radio wave propagation under cosmic conditions are discussed in the sixth and seventh chapters. The eighth and last chapter is devoted to nonlinear phenomena in plasma distributed in homogeneous space and in ac electromagnetic fields. Various events taking place in the ionosphere, magnetosphere, and interplanetary space are also discussed. (1207 references.) (R.V.J.)

Production of Plasma

Refer to abstract 15913.

Stability of Plasma

15544 (COO-1478-3) MICROINSTABILITIES IN INHOMOGENEOUS PLASMA. Progress Report, May 1, 1967–January 31, 1968. Kammash, T. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering). Contract AT(11-1)-1478. 8p. Dep. CFSTI.

Stability problems associated with magnetic mirror machines are discussed. The effect of shear on ion cyclotron instabilities and convective and absolute instabilities in more than one dimension were investigated. (M.O.W.)

15545 (IIF-LA-9) NEUSTOICHIVOST' PLAZMY S PAZLICHNOI STEPEN'YU NEODNORODNOSTI. (Instability of Plasma with Various Degrees of Non-Homogeneity). Buchel'nikova, N. S.; Salimov, R. A.; Eidel'man, Yu. I. (Akademiya Nauk SSSR, Novosibirsk, Institut Yadernoi Fiziki). 1967. 20p. (In Russian). Dep.

The instability of nonhomogeneous plasma during change of the degree of nonhomogeneity was investigated. It is shown that in slightly nonhomogeneous plasma drift waves are excited, changing over in the case of strong nonhomogeneity to azimuthal ion–sound waves. The state of the plasma and the diffusion across the magnetic field with various ion–sound instability is discussed. (tr-auth)

15546 STABILITY IN A HELICAL MAGNETIC FIELD OF A PLASMA WITH AN ANISOTROPIC PRESSURE. Aleksin, V. F.; Yashin, V. I. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 37: 1774-9(Oct. 1967). (In Russian).

A generalized energy principle is used to discuss in the drift approximation the stability of a plasma with an anisotropic pressure in the magnetic field of a stellarator. The ratio of the transverse to the longitudinal component of the magnetic field is assumed to be proportional to a small expansion parameter β, and both the transverse and longitudinal pressures of the plasma are assumed to be proportional to β^2. The change in the energy of the plasma due to an arbitrary small displacement is expanded in powers of β and it is shown that the lowest order term that can give rise to instability is proportional to β^4. The condition is derived that the β^4 term in the energy expansion be such as to stabilize the plasma; this condition is always satisfied when the plasma pressure is isotropic. Anisotropic plasma pressures giving rise to the investigated type of instability can result from injection of ions into the magnetic field of a stellarator or from cyclotron heating of the plasma ions. (ATD)

15547 KINETIC THEORY OF DRIFT-DISSIPATIVE PLASMA INSTABILITIES. Bogdankevich, L. S.; Milich, B.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 1936-9(Oct. 1967). (In Russian).

The instabilities of a nonuniform plasma are studied for the case when the product of the perturbation frequency by the electron collision frequency is much smaller than the square of the ratio of the electron thermal velocity to the wavelength, which, in turn, is much smaller than the square of the electron collision frequency. Heat conduction by the electrons is significant under these conditions. The present calculations are performed by the local method of Mikhailovskii (Sb. "Voprosy teorii plazmy," 3: 141(1963)) in which the oscillation spectrum is determined directly from the eikonal equation. The contribution of the ions to the eikonal equation is taken from earlier work of Rukhadze and Silin (Dokl. Akad. Nauk SSR, 169: 558(1966)), and the contribution of the electrons is calculated from the equations of continuity and heat balance, employing for the transverse components of the current and energy flux the expressions derived for a collision-free plasma, and for the longitudinal components, the expressions given by Gorbunov and Silin (Zh. Tekh. Fiz., 34: 385(1964)). The equations are linearized for small perturbations and the resulting dispersion equation is discussed. In the low-frequency long-wavelength region the dispersion equation has four branches, of which two represent oscillations that are independent of dissipative processes, are possible only in a plasma in which the temperature is highly nonuniform, and are very difficult to stabilize magnetically, and the other two represent oscillations that have low growth rates and depend essentially on the presence of ion–electron collisions. In the short-wavelength region there are both cyclotron and low-frequency drift-dissipative oscillations. (ATD)

15548 PLASMA STABILITY IN MAGNETIC TRAPS. I. MAGNETOHYDRODYNAMIC STABILITY THEORY. Jukes, J. D. (Culham Lab., Abingdon, Eng.). Rep. Progr. Phys., 30: 333-73(1967).

Recent developments in the linear theory of plasma stability in magnetic traps are described from a magnetohydrodynamic or quasi-fluid point of view. The stability against interchange of fairly general plasma distributions in open traps, which form magnetic wells satisfying the minimum-B criteria, is predicted in agreement with experiment, at least at low density. The situation with regard to closed traps is not so clear. Many new instabilities have been predicted as a result of including in a quasi-fluid theory fine-scale effects such as finite resistivity and ion mass. Systems stable according to "ideal" magnetohydrodynamics, either because of sufficient magnetic shear or average-magnetic-well properties, are unstable, at least in some regions, to the new but weaker instabilities. (auth) (UK)

Thermonuclear Processes

Refer to abstract 15880.

Shielding

Refer also to abstracts 15003 and 15156.

15549 THERMOSETTING RESIN MATRIX CONTAINING BORON COMPOUNDS OF SPECIFIC SIZE DISTRIBUTION AND METHOD OF MAKING. Chvatal, Theodor (to Werner H. Kreidl). U. S. Patent 3,361,684. Jan. 18, 1966.

A method of producing a shielding material for protection against biologically damaging neutron radiation was developed using a mixture of comminuted particles of which at least one member is of the group of substances consisting of lithium octoborate, lithium metaborate, purified colemanite, and purified pandermite and having less than 1% by weight of elements emitting secondary gamma radiation. The mixture also contains about 10 to 25% by weight of a liquid synthetic resin of the thermosetting type to produce a formable mixture, and particles comprising about 50 to 70% by weight of a coarse portion of an average grain size of from about 1 to 3 mm and about 30 to 50% by weight of a fine portion of an average grain size of from about 0.01 to 0.1 mm. The mixture is molded into the desired shape and allowed to set, whereby a space distribution of the comminuted particles within

the resin matrix is obtained which yields a shielding material of highest neutron-absorption cross section. (Offic. Gaz.)

Solid-State Physics

Refer also to abstracts 15197, 15480, 15659, 15919, 15920, 15924, and 15930.

15550 (AERE-R-5195) SOLUTION OF THE PHASE PROBLEM IN NEUTRON DIFFRACTION BY THE ANOMALOUS DISPERSION METHOD. Dale, D. H.; Willis, B. T. M. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1966. 20p. Dep. CFSTI. UK.

The anomalous dispersion method (well established in x-ray work for determining the phases of x-ray reflexions) can be used to solve the phase problem in neutron diffraction. Relatively few isotopes have resonances close to the thermal neutron region (wavelength ~ 1Å), but of these ^{113}Cd and ^{149}Sm show a pronounced dispersion effect, much stronger than the dispersion effect in x-ray diffraction. Measurements at two different wavelengths, preferably on different sides of the resonance, can be used to resolve the phase ambiguity associated with the anomalous dispersion method. The size of the unit cell of a non-centro symmetrical structure which can be solved by the neutron method lies within a range limited on the lower side by absorption and on the upper side by the observable intensity difference of the hkl, $\overline{hkl}$ pairs of reflections. The range is about 600 to 3,000 atoms per unit cell (P1 symmetry) for a 50% deuterated crystal containing one ^{113}Cd atom per cell, and is above 3,000 atoms per cell for a 50% deuterated crystal containing one ^{149}Sm atom per cell. For undeuterated crystals the range is narrower and the counting statistics less favorable. The solution of the crystal structure of rhombohedral insulin, of molecular weight equal to 6,000, and containing 2 or 4 ^{113}Cd atoms and 6 molecules per unit cell, using the neutron anomalous dispersion method, is a definite possibility. (auth) (UK)

15551 (AERE-R-5203) POINT DEFECTS IN MAGNESIUM OXIDE. Report on a One Day Symposium Held at A.E.R.E. (Harwell) on Friday 25th March 1966. Henderson, B. (Atomic Energy Research Establishment, Harwell (England)). May 1966. 7p. Dep. CFSTI. UK.

A brief summary is given of a one-day symposium on the above subject held at A.E.R.E., Harwell on March 25th, 1966. The main topics covered were paramagnetic resonance (including acoustic magnetic resonance), optical absorption and fluorescence, and the use of Zeeman and uniaxial stress techniques. Titles of papers were as follows: Acoustic resonance and thermal resistivity of Cr^{2+} in MgO; EPR of ions in noncubic symmetry sites in MgO; exchange-coupled Mn^{2+} pairs in MgO; vibtonic structure of Ni^{2+} in MgO; optical absorption and luminescence studies of impurities in MgO; energy levels of defects as studied by uniaxial stress and Zeeman techniques; symmetry of irradiation induced defects in MgO; optical absorption studies of irradiation damage at high doses; studies of OH^- infrared absorption in MgO. (UK)

15552 (AWRE-O-69/64) SOME INVESTIGATION ON THE EFFECTS OF NEUTRON IRRADIATION ON CARRIER LIFETIME IN ULTRA PURE SILICON. Hitchcock, A. J. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1964. 25p. Dep. CFSTI. UK.

An investigation is described on the short term stability of neutron bombardment damage in ultra-pure n-type silicon, using carrier lifetime as an index of the damage. The extent of permanent damage was also studied. (auth) (UK)

15553 (CALT-221-38) TEMPERATURE DEPENDENCE OF THE MAGNETIZATION OF AN AMORPHOUS FERROMAGNET. Research and Development Report No. 53. Tsuei, C. C.; Longworth, G.; Lin, S. C. H. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jan. 1968. Contract AT(04-3)-221. 17p. Dep. CFSTI.

The results of magnetization and hyperfine field measurements definitely indicate that the amorphous alloy $Fe_{80}P_{12.5}C_{7.5}$ is ferromagnetic. The magnetization of such an alloy varies with temperature in the same way as that of a crystalline ferromagnet, i.e., essentially according to a Brillouin function with a relatively well-defined Curie temperature. Although the magnetic moment is only slightly smaller than that of pure iron, the Curie temperature is greatly reduced possibly because of the lack of strict periodicity in the atomic arrangement. (auth)

15554 (CEA-R-3290) CONTRIBUTION A L'ETUDE DU MELANGE THERMIQUE ENTRE SYSTEMES DE SPINS NUCLEAIRES. (Contribution to the Study of Thermal Mixing Between Nuclear Spin Systems). Goldman, Maurice (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 113p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

Methods of dynamic nuclear polarization in solids based on the thermal mixing between nuclear spin systems are described. The description of the thermal mixing processes involves most of the fundamental aspects of the spin temperature theory. The experiments, conducted with paradichlorobenzene and paradibromobenzene, yield a detailed confirmation of the theoretical predictions. (auth)

15555 (COO-1197-21) EXPERIMENTAL VERIFICATION OF THE CORRELATION FACTOR FOR VACANCY DIFFUSION IN SILVER CHLORIDE. Gracey, Joseph P. (Kansas Univ., Lawrence. Dept. of Physics and Astronomy). Sept. 1967. Contract AT(11-1)-1197. 51p. Dep. CFSTI.

An investigation was made of the free vacancy experimental correlation factor for AgCl. Diffusion and conductivity measurements were made on AgCl doped with small amounts of $CdCl_2$ in the temperature range from 125 to 225°C. (M.O.W.)

15556 (COO-1368-8) FERROELECTRIC PROPERTIES OF BISMUTH FERRATE AND RELATED MATERIALS. Progress Report. Gerson, Robert; James, William J. (Missouri Univ., Rolla). Jan. 1968. Contract AT(11-1)-1368. 48p. Dep. CFSTI.

Neutron-diffraction measurements have been made on pure $BiFeO_3$ and some solid solutions containing $BiFeO_3$. The results for $BiFeO_3$ above its Neel temperature showed two peaks that could not be indexed on the basis of a simple rhombohedral cell and are very unlikely to be caused by impurities. Smaller peaks were found at the same angles in a rhombohedral perovskitic modification in the $Pb(Zr, Ti)O_3$ system, and it seems likely that this material and $BiFeO_3$ have similar superstructures. It was not possible, however, to determine the atomic coordinates of either material. The neutron-diffraction pattern was best fit with the assumption of a noncentrosymmetric point group. Some purified $BiFeO_3$ was supplied to Dr. Steward Kurz (Bell Telephone Laboratories), who found that it was capable of frequency doubling in a laser beam. This result proves that $BiFeO_3$ is definitely noncentrosymmetric. Neutron-diffraction patterns were also obtained for solid solutions in the $BiFeO_3-PbZrO_3$ system. It was found that superstructure peaks could be found in the compositional region that appears almost cubic to x-ray diffraction but is known to be ferroelectric. Apparently the displacements of oxygen atoms from cubic symmetry are responsible for the ferroelectricity. Some experiments were conducted using $PbO \cdot SnO_2$, in place of $PbZrO_3$, as an additive to $BiFeO_3-PbTiO_3$. The effects were similar, but there was more difficulty with impurity phases and incomplete reaction when the tin oxide was used. A Moessbauer study on $(BiFeO_3)_{.70}-(PbTiO_3)_{.30}$ showed a nuclear quadrupole splitting similar to that in $BiFeO_3$. Chemical techniques were developed for preparing small quantities of ^{57}Fe-enriched solid solutions for further Moessbauer spectroscopy. (auth)

15557 (COO-1616-5) MOESSBAUER, X-RAY, AND CHEMICAL STUDIES OF COBALTOUS OXIDE. Ok, Hang Nam (Purdue Univ., Lafayette, Ind. Dept. of Physics). [1967]. Contract AT(11-1)-1616. 166p. Dep. CFSTI.

Thesis.

Hyperfine Moessbauer spectra were analyzed for CoO(I), CoO(II), and CoO(I,II). A general formalism was developed for H, $e^2qQ/2$, θ, ϕ, and η from Moessbauer data by diagonalizing the interaction matrix related to the first excited state of ^{57}Fe nuclei. The chemical composition is shown to be very important in all studies. (M.O.W.)

15558 (IN-1147) MACS J: A PROGRAM FOR COMPUTING CRYSTAL PHONON DISPERSION RELATIONS, STRUCTURE FACTORS FOR NEUTRON INELASTIC SCATTERING, AND JACOBIAN MATRICES. Boyter, J. K.; Solbrig, A. W. Jr. (Idaho Nuclear Corp., Idaho Falls). Jan. 1968. Contract AT(10-1)-1230. 23p. Dep. CFSTI.

A FORTRAN IV program MACS J (PPCo 40*0929) is described which computes (a) the dynamical matrix for the harmonic oscillations of a crystal, (b) the eigenvalues and eigenvectors of this matrix, (c) the corresponding structure factors for coherent single-phonon scattering of neutrons, and (d) Jacobian matrices for use in adjusting force constants to fit calculated dispersion curves to observed dispersion curves. Appendixes contain discussion of fitting procedures and the linearity assumption as well as sample input for calculation of a Jacobian matrix. Running time on an IBM 7044 (32K, batch processing) for the 7 problems required to calculate a Jacobian with 8 rows and 6 columns for BeO (4 atoms per primitive cell) is less than 5 minutes. (auth)

15559 (INP-508-PL) MATERIALY IV ZIMOWEJ SZKOLY FIZYKI. (Lectures of the IV Winter School of Physics). (Inst. of Nuclear Physics, Krakow (Poland)). Mar. 1967. 57p. (In Polish). Dep.

Separate abstracts were prepared for 4 of the 5 included lectures. (M.O.W.)

For abstracts of individual papers see: 15560–15563.

15560 (INP-508-PL, pp 1-5) ROLA PROCESOW RELAKSACYJNYCH W KORELACJACH KIERUNKOWICH PROMIENIOWANIA GAMMA. (The Role of Relaxation Processes in Correlative Directional Gamma Radiation). Hrynkiewicz, Andrezej Z. (Inst. of Nuclear Physics, Krakow (Poland)). (In Polish).

Perturbation of directional correlation for polycrystalline and liquid sources, in the absence of the external magnetic field is reviewed. The main reactions in perturbation processes include static reactions, consisting of the interaction of the electrical moment with the axially symmetrical gradient of the electric field of the polycrystalline source; reactions of the magnetic moment of the nucleus with the internal magnetic field of the polycrystalline source; and reactions of the superfine electron sheath with the magnetic moment. A formula is given for the attenuation correlation coefficient, G_k (t) for each case, indicating the parameters, on which the G_k (t) function depends. For time-dependent reactions two contributions must be considered: (1) The electric quadrupole reaction in the liquid source, and (2) magnetic reaction in the paramagnetic substances with a short electron-spin relaxation time. Formulas to calculate the attenuation correlation coefficients are given for both cases. (TTT)

15561 (INP-508-PL, pp 6-17) RELAKSACJA W MAGNETYCZNYM REZONANSIE JADROWYM DLA UKLADOW WIELOSPINOWICH. (Relaxation of Multispins Systems in Nuclear Magnetic Resonance). Blicharski, Jerzy S. (Jagellonian Univ., Krakow (Poland). Inst. of Physics). (In Polish).

Results of relaxation calculations of the magnetic resonance for diatomic gases of arbitrary nuclear spin and for liquids containing multispin molecules are presented, discussing available literature data on the theory of relaxation and deriving analytical relationships involving reaction Hamiltonian. Both identical and nonidentical spins were considered in the calculations. The relaxation theory in the liquids was examined by considering a system of liquid molecules consisting of nuclei with both identical and arbitrary spins. The longitudinal relaxation time was calculated for the multispin system considered. Several simplifying assumptions, corrections, and approximations were introduced in the analytical method. The calculated longitudinal relaxation times were compared with earlier experimental values, for six liquids. Fair agreement was found in some cases. (TTT)

15562 (INP-508-PL, pp 18-38) RELAKSACJA JONOW PARAMAGNETYCZNYCH GRUP LANTANU I ZELAZA W REZONANSIE ELEKTRONOWYM. (Ion Relaxation of Paramagnetic Groups of Lanthanum and Iron in Electronic Resonance). Jasinski, Andrzej (Inst. of Nuclear Physics, Krakow (Poland)). (In Polish).

The ion relaxation mechanisms of paramagnetic groups of lanthanum and iron in some crystals were studied, examining the directional correlation of the nuclear radiation of highly deformed lanthanum-group nuclei and the Mössbauer effect of iron in the group. The relaxation time was measured by the saturation method. An expression was derived for the Hamiltonian of the paramagnetic ion in the crystal lattice; it enables calculation of the values of all the operators and the spin. Orbach's theory on the relaxation of paramagnetic lanthanum-group ions is reviewed. The spin relaxation of the iron-group ions is the result of the spin–phonon interaction, caused by the modulation of the crystal field by thermal excitation of the crystal lattice, which in turn modifies the orbital path of the electrons. The analytical method involved the determination of the equivalent Hamiltonian for the spin–phonon interaction. (TTT)

15563 (INP-508-PL, pp 46-57) PRZEGLAD ODDZIAZYWAN JADRA Z POWLOKA ATOMOWA OBSERWOWANYCH W EFEKCIE MOESSBAUERA. (Interaction of Nucleus With Atomic Envelope Observed in the Moessbauer Effect). Bara, Jozef (Jagellonian Univ., Krakow (Poland). Inst. of Physics). (In Polish).

Interactions between the nucleus and the surrounding atomic envelope may involve (1) interactions between nuclei and electric charges of the atomic envelopes; (2) electrical interactions of the quadrupole moment with the electric field generated by the atomic envelope, and (3) magnetic dipole interactions of the magnetic moment of the nucleus with the external field of the atomic envelope. The first type of reactions causes the isomeric shift of nuclear levels, the degree of which depends on the energy level. Differences in the electron densities of emitting and absorbing nuclei cause a shift of the Mössbauer lines. The isomeric shift of ferrous and ferric ions were studied to measure electron density in iron nuclei. Interactions in iron compounds were examined to derive the Hamiltonian for magnetic dipole interactions. The Mössbauer effect may be used to study structural changes of atomic envelope, using magnetic atoms in very dilute solid solution of nonmetallic paramagnetic substances. (TTT)

15564 (IS-T-213) ELECTRON PARAMAGNETIC RESONANCE OF GADOLINIUM IN SODIUM SILICATE GLASSES. Johnstone, James Keith (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 67p. Dep. CFSTI.

Thesis.

The X-band (≈9800 Mhz) electron paramagnetic resonance spectra of gadolinium in sodium-silicate glasses at 77°K are presented. The spectra are characterized by peaks at g-values of $g \approx 2.0$, 2.85 and 5.9. The experimental g-values are correlated with g-values obtained from the solution of the effective spin Hamiltonian. Comparison of the experimental and theoretical g-values indicates that the glasses have a two phase structure with each phase providing a characteristic symmetry site for the gadolinium ion. The possibility of a third symmetry site existing in the phase boundary is also discussed. Each symmetry site gives rise to one of the characteristic g-values obtained experimentally. Comparison of the relative intensities of the characteristic peaks of the spectra indicates definite trends toward ordering corresponding to compounds in the high soda phase. The solution of the effective spin Hamiltonian is presented. (auth)

15565 (LA-3626) ENERGY PENETRATION INTO HARMONIC AND ANHARMONIC DISORDERED LATTICES. Payton III, Daniel N.; Rich, Marvin; Visscher, William M. (Los Alamos Scientific Lab., N. Mex.). Oct. 1967. Contract W-7405-eng-36. 21p. Dep. CFSTI.

A discussion is given of a computer-generated film which gives a direct graphical representation of penetration of an energy wave into two-dimensional isotopically disordered lattices. The blockage of energy flow due to low concentrations of light impurities in a host lattice is contrasted with that due to like arrangements of heavy impurities. Similarly, the differences between energy flow into harmonic and anharmonic lattices are considered. The film demonstrates that energy flows more easily through a disordered anharmonic lattice than through an equivalent harmonic lattices and that it is less impeded by light impurities than by heavy ones. (auth)

15566 (NYO-2150-40) SOLID STATE PHYSICS; MAGNETIC PHENOMENA. Progress Report, January 1, 1967–December 31, 1967. Bowers, R.; Silsbee, R. H. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Jan. 1968. Contract AT(30-1)-2150. 13p. Dep. CFSTI.

CYANOGEN FLUORIDES — electron spin resonance spectra of FCN^- radical in potassium chloride
CYANOGEN CHLORIDES — electron spin resonance spectra of $ClCN^-$ radical in potassium chloride
HYDROCYANIC ACID — electron spin resonance spectra of HCN^- radical in potassium chloride
LITHIUM IONS — electron spin resonance spectra in potassium chloride
COPPER ALLOYS & SYSTEMS — Cu–Mn, electron spin resonance studies
POTASSIUM, INDIUM — magnetoresistance measurements on single-crystal, using helicon waves
METALS, SUPERCONDUCTORS — helicon wave studies
ALUMINUM, SILVER — acoustic wave production by electromagnetic excitation
NIOBIUM — superconductivity, helicon studies of
INDIUM — thermal resistance and Righi–Leduc effect measurements
LITHIUM, TETRAAMINE- — resistivity measurements at low temperatures (D.L.C.)

15567 (NYO-3564-9) STARK EFFECT ON THE RELAXED EXCITED STATES OF THE F CENTER. Bogan, Larry Duane (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 1968. Contract AT(30-1)-3464. 158p. Dep. CFSTI.

Thesis.

A phase-sensitive detection system was used in conjunction with an applied ac electric field of 5 to 50 kV/cm (zero to peak) to detect small induced changes of less than 1% in the F-center luminescence. Quadratic Stark effects were observed for the F center in KCl, KF, NaF, RbCl, and NaCl. The effects were qualitatively the same in all these alkali halides and consisted of an induced polarization of about 1% and a red shift of about 0.2 MeV of the emission band at an rms field strength of 30 kV/cm. In KCl and RbCl there was some indication of an induced broadening of the band. Between 2° and 50°K these effects are independent

of the temperature but at higher temperatures the polarization and broadening decrease to zero. The polarization has been analyzed and shown to be an increase of the intensity of the emission polarized parallel to the direction of the applied field of twice the magnitude of the decrease in the intensity polarized perpendicular to the field. Measurements of the Stark effects in CsF showed them to be two orders of magnitude smaller and of different character than those in the other alkali halides. The data were analyzed in terms of the Stark effect on the diffuse-metastable-2S relaxed excited state. This model is shown to be consistent with other experiments as well as the data presented here, and predicts that the hydrogenic 2P and 2S states are strongly mixed by electric fields produced by longitudinal optic-mode lattice vibrations with the levels separated by about 0.01 eV. The lower state has most of the S-like character. Other possible models for the relaxed excited states were analyzed in terms of the Stark effect and considered less likely as explanations of the data. (auth)

15568 (NYO-3699-23) THE DYNAMICS OF A NON-HARMONIC SUBSTITUTIONAL IMPURITY IN A DYNAMIC HOST LATTICE. Report No. 879. Bowen, Samuel Philip (Cornell Univ., Ithaca, N. Y. Materials Science Center). Sept. 1967. Contract AT(30-1)-3699. 114p. Dep. CFSTI.

Thesis.

A study was made of small quantum systems coupled to a many-body quantum field. The purposes of the study are: (1) to develop a formalism for calculating properties of a small system in contact with a phonon bath, and (2) to apply this technique to a certain type of substitutional impurity in pure host crystals. (M.O.W.)

15569 (ORNL-TM-2114) DETERMINATION OF OPTICAL CONSTANTS OF PALLADIUM BY ELLIPSOMETRY. Riedinger, Margaret S.; Emerson, L. C. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Thesis. Submitted by Margaret S. Riedinger to Vanderbilt Univ., Nashville.

Techniques for making ellipsometric measurements in the ultra-high vacuum region were developed. The techniques were used to determine the optical constants of Pd in the visible and infrared regions. Results are compared with measurements of other investigators using photometric and interference methods. (A.G.W.)

15570 (SC-RR-67-2928) ELECTRIC-FIELD-DEPENDENT DIELECTRIC NONLINEARITIES OF ELECTROMORPHIC CERAMICS: DYNAMIC VS STATIC VALUES. EerNisse, E. P. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 20p. Dep. CFSTI.

The first derivative of the complex dielectric constant with respect to electric field was measured for three diffuse transition electromorphic ceramics under the dynamic conditions of parametric device operation. The measurements were made at 500 KHz and 25°C. These dynamic values are as much as 30% smaller than the corresponding slopes of 500-KHz small-signal dielectric constant vs static electric bias field curves at 25°C. The fact that the dynamic nonlinearity is smaller than the static value is attributed to the relaxator nature of the dielectric behavior of such ceramics. Of the antiferroelectric and two ferroelectric compositions investigated, the antiferroelectric composition was capable of more efficient high-frequency device operation because of its lower losses and larger dynamic nonlinearities at higher frequencies. (auth)

15571 (Y-1603) BASIC LANGUAGE COMPUTER PROGRAM FOR CALCULATING INTERPLANAR SPACINGS. Budelov, P. R.; Cullipher, J. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Feb. 15, 1968. Contract W-7405-eng-26. 24p. Dep. CFSTI.

A computer program has been developed for calculating the interplanar spacings (d,A) of a crystal, given the crystal system and the lattice parameters. The program, written in the BASIC computer language, generates and prints only valid Miller indices and interplanar spacings for the crystal system specified. (auth)

15572 (AD-663931) THEORY OF NUCLEAR MAGNETIC RESONANCE. Aleksandrov, I. V. Translated from pp 1-208 of Teoriya Yadernogo Magnitnogo Rezonansa, Izdatel'stvo Nauk, Moscow, 1964. 184p. (FTD-MT-65-429). CFSTI.

This monograph is an attempt to expound certain basic contemporary concepts on the theory of nuclear magnetic resonance [NMR]. The literature list contains a number of books and also survey articles devoted to NMR. However, in all these works basic attention is given to graphic physical interpretation of phenomena and to experimental problems of this method and its applications. Theoretical questions of NMR in available books and survey articles receive comparatively little space. In this monograph the authors ignore entirely questions connected with experimental techniques in NMR, referring the reader to cited works. They assume also that the reader is familiar with the essence of the method and basic physical concepts connected with it. (auth)

15573 (NP-tr-1612) ROLE OF FOCUSING COLLISIONS IN THE PROCESS OF RADIATION ANNEALING OF POINT DEFECTS IN DIAMOND. Al'tovskii, I. V.; Karpukhin, V. I.; Nikolayenko, V. A.; Platonov, P. A. (Akademiya Nauk SSSR, Moscow, Institut Atomnoi Energii). Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE-1091. 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A theoretical investigation was made on the basis of a proposed model of radiation annealing using the concept of dynamic crowdions. An expression was obtained for the dependence of the volumetric expansion of the lattice parameter of diamond on the total dose of neutrons. The length of both the dynamic crowdions and the cross-section for annihilation of a vacancy and crowdion for diamond were also obtained. (auth)

15574 (NP-tr-1614) OPTICAL ABSORPTION AND PHOTOCHEMICAL BEHAVIOUR OF SH', S', AND S'' CENTRES IN KCl CRYSTALS. Fischer, F.; Gruendig, H. Translated by D. Verdin (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Phys., 184: 299-309(1965). 14p. Dep.

The optical absorption and photochemical properties of SH' centers, analogous to OH' centers, found in polycrystalline KCl solidified from a sulfur-containing melt were investigated. It is shown that the SH' centers can be quantitatively converted into new secondary centers by photochemical reactions and by reduction with excess K. These secondary centers are interpreted as S' and S'' centers. (A.G.W.)

15575 (UCRL-Trans-10205) THE REINFORCING EFFECT OF IRRADIATION ON THE LUMINESCENCE OF (Zn,Cd)S:Mn EXCITED BY α RAYS; STUDY OF THE INDIVIDUAL SCINTILLATIONS. Geoffroy, A. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., 261: 5072-5(1965). 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The present article is concerned with the reinforcing action of irradiation on the total luminous emission and on the individual scintillations in (Zn,Cd)S:Mn excited by the α rays of ^{210}Po. (auth)

15576 (UCRL-Trans-10207) STRUCTURE OF THE SURFACE OF ZINC OXIDIZED AT VARIOUS TEMPERATURES. Matyas, Milos. Translated by D. McCallum for Univ. of California Lawrence Radiation Lab., Livermore, from Czech. J. Phys., 3: 166-7 (1953). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Thin films of Zn vacuum-deposited on Formvar were allowed to stand in air for 24 hr and an electron-diffraction diagram was made. In addition to lines corresponding to Zn, the diagram also contained lines corresponding to a hexagonal structure having the parameters a = 3.18 and c/a = 1.65. When the samples were oxidized at progressively higher temperatures, further lines due to this anomalous structure appeared up to 250 to 280°C, at which point these lines disappeared and were replaced by lines corresponding to the normal structure of ZnO. The anomalous lines are attributed to a ZnO modification formed in very thin layers so that it matches its structure to that of the support. Above 250° this modification recrystallizes to give the normal ZnO structure. (A.G.W.)

15577 MAGNETIC HYPERFINE STRUCTURE IN THE MOESSBAUER SPECTRA OF $K_3Fe(CN)_6$. Oosterhuis, W. (Carnegie-Mellon Univ., Pittsburgh); Debenedetti, S.; Lang, G. Phys. Lett., 26A: 214-16(Jan. 29, 1968).

Paramagnetic hyperfine structure in the Moessbauer spectrum of $K_3Fe(CN)_6$ diluted in diagmagnetic $K_3Co(CN)_6$ or in glycerol was observed at 4°K. The spectra with and without external magnetic field are consistent with ESR results. (auth)

15578 THE THERMOLUMINESCENCE, EPR, AND ELECTRON ABSORPTION SPECTRA OF IRRADIATED SILICATE GLASS. Sidorov, T. A.; Tyul'kin, V. A.; Aksenov, V. S. Dokl. Akad. Nauk SSSR, 175: 1094-6(Aug. 11, 1967). (In Russian).

Glasses, with compositions of $1Na_2O \cdot 12ZnO \cdot 6SiO_2$ (Zn-52) and $1.5\ Na_2O \cdot 1.5ZnO \cdot 6SiO$ (Zn-53) were exposed to a dose of 10^7 R using a ^{60}Co γ source. After heating the glass from 20 to 400°C, the thermoluminescence of glass No. Zn-53 exhibited maxima at 200 and 275°C. The thermoluminescence curve of glass No. Zn-52 had a strong maximum at 200° and weaker ones at 270 and 110°C. The electron paramagnetic resonance of the glasses, both before and after heating to 200°C were characterized by a doublet with a g = 2.01. The α and β components of the line were changed after the heating. The electron absorption spectrum of glass No. Zn-52 had 2 maxima in the visible range: at 4400 and 6200 Å; both of these maxima became less intensive upon heating to 200°C. It was concluded that heating of the irradiated specimens disturbs the

vacancy centers at the last, not cross-linked oxygen atom, next to which there are no sodium atoms. The results also indicated that the γ-irradiated sodium zinc silicate glasses possess the same centers as the two-component sodium silicate glasses. No centers connected with zinc atoms were observed. (TTT)

15579 RADIOCOLLOID FORMATION OF METALLIC LITHIUM. Vitol, A. Ya. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 123-4 (1967). (In Russian).

Colloidal lithium is formed on irradiating LiF monocrystals in a reactor at large doses of 10^{19} neutrons/cm^2 and higher. Radiation heating or the sample temperature is an important factor in making the metal colloid. A LiF 60 mm rod (16 × 5 mm^2 cross-section) was irradiated in a reactor at temperatures of 630 and 500°K. The rods were given an integrated dose of 8.5×10^{17} neutrons/cm^2 at a neutron flux of 1.65×10^{12} neutrons cm^{-2} sec^{-1}. The rod showed a number of differently colored zones which were examined by electron paramagnetic resonance (EPR). Zones 1 and 2 gave an EPR signal from unaggregated F centers. Zone 3 is a transition zone, while Zone 4 shows the formation of colloidal metallic lithium. Zone 5 shows the presence of clusters of F centers. Colloids of metallic lithium in LiF crystals can be formed in substantial amounts at integrated neutron doses of <10^{18} neutrons/cm^2. (TTT)

15580 THE EFFECT OF REACTOR IRRADIATION CONDITIONS ON THE CHANGES OF LiF CRYSTAL DENSITY. Kalnin', D. O.; Lyushina, A. F. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 125-6(1967). (In Russian).

Samples of LiF were irradiated in various containers (aluminum and quartz) in moist and dry channels of the BEK reactor. The change in density Δd/d was determined as a function of the absorbed neutron dose which was varied from 10^{15} to 10^{19} neutrons/cm^2. The surface temperature of the samples was estimated to be 310°K in the moist channels and 600°K in the dry channels. Heating of the samples led to partial annealing of the radiation defects and a decrease in Δd/d. The value of Δd/d differed by an order of magnitude as a function of the irradiation conditions at the same value of integral dose. Hence, LiF crystals having a natural isotopic composition cannot be used as dosimeters in reactors. (TTT)

15581 FERMI SURFACES OF COPPER–ALUMINUM ALLOYS BY POSITRON ANNIHILATION. Fujiwara, Kunio; Sueoka, Osamu; Imura, Toru (Tokyo Univ.). J. Phys. Soc. Jap., 24: 467-75 (Mar. 1968).

A novel technique in positron annihilation (J. Phys. Soc. Japan, 20: 1533(1965); 21: 1947(1966)) enabled one to survey the Fermi-surfaces of the α-phase alloys in the system Cu–Al. The results were as follows: (1) The neck radius does not increase monotonically with increasing content of Al, but shows an oscillatory behavior having a maximum at 2 ~ 3 at. % Al and a minimum at 5 ~ 6 at. % Al. (2) For the alloys containing Al more than about 10 at. %, the necks protrude beyond the hexagonal zone faces. (3) The Fermi surface swells out gradually in the ⟨200⟩ directions with the addition of Al atoms. (4) A possible model of the Fermi surface was proposed for 10.6-at. % alloy by taking account of four angular-correlation curves corresponding to different orientations of crystals. (auth)

15582 MAGNETIC PROPERTIES OF RARE EARTH HYDROXIDES. Wolf, W. P.; Meissner, H.; Catanese, C. A. (Yale Univ., New Haven). J. Appl. Phys., 39: 1134-6(Feb. 1, 1968).

The rare-earth hydroxides, $R(OH)_3$ with R = La to Yb and Y form a series of simple magnetic crystals isostructural with the hexagonal rare-earth trichlorides. Compared with most ionic rare-earth crystals they have relatively small lattice parameters, and one may therefore expect magnetic cooperative effects at readily accessible temperatures. The first magnetic measurements on small, hydrothermally grown single crystals (1 to 10 mg) are reported; they show that $Tb(OH)_3$, $Dy(OH)_3$, and $Ho(OH)_3$ order ferromagnetically at 3.72, 3.50, and 2.55°K, respectively, while $Nd(OH)_3$ and $Gd(OH)_3$ undergo more complex antiferromagnetic transitions near 1.7 and 2.0°K. $Er(OH)_3$ remains paramagnetic down to 1.2°K. Magnetization measurements on $Tb(OH)_3$, $Dy(OH)_3$, and $Ho(OH)_3$ in fields up to 14 kG give saturation moments (corrected for Van Vleck temperature-independent paramagnetism) of 1350 emu/cc (9.0 μ_B/ion), 1418 emu/cc (9.6 μ_B/ion), and 1121 emu/cc (7.6 μ_B/ion) parallel to the c axis and almost zero perpendicular to the c axis. The correspondingly large and anisotropic magnetic dipole interactions account approximately for the observed Curie temperatures, suggesting that $Tb(OH)_3$, $Dy(OH)_3$, and $Ho(OH)_3$ may be among the simplest examples of Ising-like systems studied so far, with dominant interactions along linear chains of nearest neighbors. Single crystals are found to be chemically stable with apparently good optical properties, suggesting useful applications to magneto-optic devices. These are discussed briefly (auth)

15583 MAGNETIC INTERACTIONS IN Tb AND Tb–10 PERCENT Ho FROM INELASTIC NEUTRON SCATTERING. Moeller, H. Bjerrum (Atomenergikommissionen, Riso, Denmark); Houmann, J. C. Gylden; Mackintosh, A. R. J. Appl. Phys., 39: 807-15(Feb. 1, 1968).

The magnon dispersion relations and lifetimes have been measured in Tb and Tb–10% Ho alloy by inelastic neutron scattering, in regions of both ferromagnetic and spiral ordering. In the ferromagnetic phase, the magnon energy is generally finite at zero wavevector and rises quadratically at low q. The magnon energies scale approximately with the magnetization. In the spiral phase the magnon energy rises linearly from zero at low q. The Fourier-transformed exchange parameter J(q) has pronounced peaks in the c direction, which are ascribed to transitions between states close to the Fermi surface. These peaks are less pronounced in the ferromagnetic phase. The primary mechanism limiting the magnon lifetimes appears to be interaction with the conduction electrons. In the alloy, the lifetime for magnons propagating in the c direction in the ferromagnetic phase falls abruptly at about q = 0.35 Å^{-1}; this may be because of the exchange splitting of the conduction-electron energy bands. The dispersion curve for magnons propagating in the a direction is considerably perturbed around 4 MeV, and this is probably due to resonant scattering on the Ho impurities. A strong coupling occurs over the same energy range in the alloy between magnons and transverse phonons propagating in the c direction. This effect is considerably smaller in pure Tb. (auth)

15584 STRESS DEPENDENCE OF THE g FACTORS OF Yb^{3+} IN ThO_2 AND Ho^{2+} IN CaF_2. Tachiki, M. (Univ. of California, Los Angeles); Sroubek, Z.; Zimmermann, P.; Abraham, M. M. J. Appl. Phys., 39: 977-9(Feb. 1, 1968).

The changes of the spin-Hamiltonian parameters g and A have been measured for Yb^{3+} in ThO_2 and Ho^{2+} in CaF_2 (both in cubic sites) as a function of applied stress. The stress-induced crystalline field is calculated in point-charge approximation and the g-shifts are obtained from the second-order perturbation calculations of this crystalline field and the Zeeman energy. In the case of $CaF_2:Ho^{2+}$ stressed along [001] and in the case of $ThO_2:Yb^{3+}$ stressed along [111], the contributions of the second-order crystalline field coefficients to the g-shift are dominant, and very good agreements with experiment are obtained without any shielding of the crystalline field. In the case of $CaF_2:Ho^{2+}$ stressed along [111], the correct sign of Δg is obtained, but the absolute magnitude is four times larger than the experimental value. To get agreement with experiment, the contribution of the fourth-order crystalline field coefficient, which is dominant in this case, should be multiplied by 3. The oxygen polarization contribution to the second-order crystalline field coefficient in the case of $ThO_2:Yb^{3+}$ is six times larger than the point-charge contribution, and thus the calculated g-shift becomes five times larger than the observed one. The discrepancy is attributed to the inadequacy of the usually used oxygen polarizability. (auth)

15585 MAGNETIZATION CURVES OF Fe–Ni (50–50) SINGLE CRYSTALS ORDERED BY NEUTRON IRRADIATION WITH AN APPLIED MAGNETIC FIELD. Pauleve, J.; Chamberod, A.; Krebs, K.; Bourret, A. (CEN, Grenoble, France). J. Appl. Phys., 39: 989-90(Feb. 1, 1968).

Spherical Fe–Ni (50–50) single crystals were ordered by neutron irradiation at 295°C in the presence of a magnetic field. Magnetization curves and magnetic anisotropy energy measurements demonstrate the very important directional effect of the irradiation magnetic field on the bulk anisotropy of the single crystal. When the magnetic field is applied along a fourfold axis, the bulk magnetic anisotropy is tetragonal with a very large value for K_3. When the magnetic field is applied along a three fold axis, the bulk magnetic anisotropy is cubic and the threefold axis becomes an easy axis of magnetization; the magnetization measured along the easy direction reaches saturation with a certain law of approach, while the magnetization measured along the [100] direction reaches saturation immediately. The model proposed by Néel, in which three types of quadratic ordered domains are assumed to be strongly coupled, fits well the experimental results. An electron-microscopy image shows the different types of ordered domains and the superlattice spots. (auth)

15586 INFRARED ZEEMAN EFFECT FOR Ce^{3+} IN $LaCl_3$. Bagguley, D. M. S.; Vella-Coleiro, G. (Oxford Univ.). J. Appl. Phys., 39: 973-4(Feb. 1, 1968).

The Zeeman splittings of the lowest $^2F_{5/2}$ and $^2F_{7/2}$ levels for Ce^{3+}

in $LaCl_3$ have been investigated in fields up to 200 kG at 77 and 27°K. The results obtained at 27°K are compared with the predictions from crystal-field theory. (auth)

15587 MAGNETIC PROPERTIES OF fcc RARE EARTH–THORIUM ALLOYS. Child, H. R.; Koehler, W. C.; Millhouse, A. H. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Appl. Phys., 39: 1329-30(Feb. 1, 1968). (ORNL-P-3302).

A neutron-diffraction study of rare earth–thorium alloys having the (fcc) structure has been carried out at temperatures ranging from room temperature to 1.3°K. For alloys of the heavy rare earth metals Tb, Ho, and Er, the fcc field starts at approximately 50 at. % Th. In a typical case the diffraction pattern at low temperatures exhibits broad diffuse maxima due to magnetic scattering, which are centered at scattering angles and are 0.3 and 0.8 of that of the (111) nuclear reflection. The pattern can be interpreted in terms of short-range antiferromagnetic correlations. These results are to be contrasted with those previously found for the rare earth-rich hcp alloys in which dilution by thorium stabilizes the ferromagnetic phase. For alloys of the light metals, Pr and Nd, the fcc structure is found in alloys containing 20 at. % Th. The magnetic scattering from such an alloy with Nd is similar to that observed for a polycrystalline specimen of the pure metal in which half the atomic sites have local symmetry which is cubic. It is probable that the magnetic structure of the fcc alloy is similar to the arrangement of moments on the cubic sites in the pure metal. The corresponding Pr-based alloy showed no magnetic ordering to 1.3°K. (auth)

15588 LOW-LYING CRYSTAL-FIELD SPECTRA OF RARE EARTH COMPOUNDS. Bloor, D.; Ellis, E.; Martin, D. H.; Wadham, A. (Queen Mary Coll., London). J. Appl. Phys., 39: 971-2(Feb. 1, 1968).

The crystal-field splitting of the degenerate ground state of rare earth ions produces energy differences that correspond to far-infrared frequencies (10 to 200 cm^{-1}). Absorption spectra of certain rare earth double nitrates, ethyl sulphates, and oxides, cooled to liquid helium temperatures, have been observed in this frequency range. The positions of the absorption lines have been compared with values deduced from optical and other measurements. In general the agreement is good. Measurements of linewidths with different concentrations of paramagnetic ions indicate that spin–lattice relaxation and electric quadrupole interaction are the predominant line-broadening mechanisms. In the case of Pr^{3+} in La ethyl sulphate, splitting of non-Kramers degenerate levels leads to further broadening. The splitting of the crystal-field levels of Er_2O_3 in the antiferromagnetic state has been observed, but not yet fully analyzed. (auth)

15589 INTERACTION CONSTANTS IN $CeCl_3$. Landau, D. P.; Birgeneau, R. J.; Hutchings, M. T.; Wolf, W. P. (Yale Univ., New Haven). J. Appl. Phys., 39: 975-7(Feb. 1, 1968). (YALE-3227-38).

Results of EPR measurements on Ce^{3+} pairs in $LaCl_3$ are combined with susceptibility and specific-heat measurements on single crystals of $CeCl_3$ to obtain estimates of the eight parameters that characterize the interactions between nearest and next nearest Ce^{3+} neighbors. It is found that the major part of the interactions can be accounted for by magnetic dipole–dipole and second-order electric quadrupole–quadrupole couplings, but there is evidence for some additional effects such as anisotropic exchange or higher-order electric multipole interactions. The dominant term is an antiferromagnetic Ising coupling between nearest neighbors which form linear chains along the c axis. This suggests a simple ordered state for $CeCl_3$, which has been observed to undergo a single sharp transition at 0.27°K. However the coupling between neighboring chains is complicated by cancellations resulting from the high symmetry of the cation lattice and the problem of long-range order is found to be similar to that in the antiferromagnetic triangular Ising model for which no simple ground state can be predicted although all the interactions are known. (auth)

15590 ACTIVATION ENERGY AND ANNEALING KINETICS OF REMANENCE GROWTH CAUSED BY LOW-TEMPERATURE MAGNETIC ANNEAL OF ELECTRON-IRRADIATED NICKEL–IRON. Sery, R. S.; Gordon, D. I. (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 39: 991-2(Feb. 1, 1968).

Defect annealing studies were made on a nickel–iron alloy (79 Ni–16 Fe–5 Mo) irradiated at 35 ± 7°C with 6×10^{16} 1-MeV electrons/cm^2. Samples used were 10-mil-thick polycrystalline rings. Magnetic remanence measured at 25°C following magnetic anneals in the 40 to 140°C temperature range was the defect-sensitive parameter studied. Isochronal magnetic annealing for 1-hr periods with 10°C steps showed a characteristic annealing temperature (T_a) of ~80°C. Isothermal magnetic annealing curves at 75 and 95°C, used to obtain activation energy (E) by the cross-cut method, gave a value of E = 1.07 ± 0.15 eV. As a check on technique, the combined isothermal–isochronal method was used and gave E = 1.15 ± 0.2 eV. Second-order chemical-rate annealing kinetics was indicated from the isothermal curves. In a related experiment, Chamberod et al. quenched a 50 Ni–Fe alloy and made annealing studies of time decrease of permeability. Their data show T_a between 70 and 110°C and E = 1.1 ± 0.15 eV. Because quenching is an established method of introducing monovacancies in metals, the values of E and T_a obtained from annealing the quenched samples can be associated with the migration of vacancies. In view of the fact that the values of E and T_a obtained for the electron-irradiated samples match those obtained for quenched samples of similar materials, it is inferred that the primary defect involved in the process of increasing magnetic remanence in the range of 40 to 120°C is the sample vacancy. Its migration during magnetic anneal permits like-atom-pair directional ordering to increase uniaxial anisotropy and remanence. (auth)

15591 TEMPERATURE DEPENDENCE OF THE MAGNETIC EXCITATIONS OF URANIUM DIOXIDE. Dolling, G.; Cowley, R. A. (Chalk River Nuclear Labs., Ont.). J. Appl. Phys., 39: 1111-13(Feb. 1, 1968).

The magnetic excitations of UO_2 have been measured by inelastic neutron-scattering techniques with the triple-axis crystal spectrometer at the C5 facility of NRU. On increasing the temperature, the neutron groups from the modes of higher (>1.5×10^{12} Hz) frequency decreased slightly in frequency, barely increased in width, but decreased markedly in intensity, and were not observable above T_N[(30.5 ± 0.5)°K for our specimen]. For example the results for the frequencies of the modes with scattering vector Q = (0.5, 0.5, 2.5)$2\pi/a$ are ($\nu(T) \times 10^{12}$ Hz): $\nu(9) = 2.02 \pm 0.03$, $\nu(21) = 2.00 \pm 0.04$, $\nu(25.3) = 1.95 \pm 0.05$, $\nu(27.0) = 1.75 \pm 0.05$, $\nu(29.5) = 1.50 \pm 0.07$. The neutron groups from the modes with lower frequencies decreased more markedly in frequency, but also showed little increase in width and were not observed above T_N. The experiments indicate that the modes of lowest frequency, which appeared to have almost zero frequency at T_N, are closely associated with the transition. These measurements, together with the strong magnon–phonon coupling in UO_2 and the known temperature dependence of the elastic constants, suggest that the transition in UO_2 is a Jahn–Teller distortion of the lowest-triplet state coupled to an antiferromagnetic ordering. (auth)

15592 ANISOTROPIC MAGNETIZATION OF TmSb. Vogt, O. (Eidgenoessische Technische Hochschule, Zurich); Cooper, B. R. J. Appl. Phys., 39: 1202-4(Feb. 1, 1968).

The experimental observation, with pulsed field, of the anisotropy in magnetization theoretically predicted for single crystals of TmSb is reported. Agreement with crystal-field-only theory is excellent at 1.5°K. At 20.4°K, agreement between isothermal theory and experiment is poorer. This discrepancy can be explained if spin–lattice relaxation effects cause the observed magnetization to be a mixture of isothermal and adiabatic effects. (auth)

15593 A LOCALIZED-ELECTRON TO COLLECTIVE-ELECTRON TRANSITION IN THE SYSTEM (La, Sr)CoO_3. Raccah, P. M.; Goodenough, J. B. (Massachusetts Inst. of Tech., Lexington). J. Appl. Phys., 39: 1209-10(Feb. 1, 1968).

Crystallographic, magnetic, and electrical studies of the system $La_{1-x}Sr_xCoO_{3-0.00+0.01}$ for $0 \leq x \leq 0.5$ give indirect evidence for the presence of chemical inhomogeneities separating strontium-free regions, where localized "3d" electrons occur at thermally excited high-spin Co^{3+} ions, from strontium-rich regions, where the "3d" electrons are collective and give ferromagnetism at low temperatures. These different regions occur within the same rhombohedral perovskite crystal and appear to represent two different electronic phases within the same crystallographic phase. A schematic band model for the ferromagnetic phase is presented. (auth)

15594 MAGNETIC PROPERTIES AND NUCLEAR MAGNETIC RESONANCE OF DILUTED (Gd, Zr)Zn_2. Asanuma, M.; Yamadaya, T. (Matsushita Research Inst. Tokyo, Inc., Ikuta, Japan). J. Appl. Phys., 39: 1244-5(Feb. 1, 1968).

The magnetic and NMR properties of $Zr_{1-x}Gd_xZn_2$ ($0 \leq x \leq 0.05$) have been investigated to clarify the influence of localized magnetic moments on conduction electron ferromagnet $ZrZn_2$. The dependence of magnetization intensity of Gd concentration shows that the Gd atoms are S states and the spin polarization of conduction electrons by a localized Gd moment does not take place. Moreover, ferromagnetism would disappear above x = 0.025. The hyperfine field of Zr in $ZrZn_2$ is –38 kOe, and is remarkably less than usual for transition metals. This result is explained by assuming mixing of the 4d and 5s wave functions. (auth)

15595 VERY WEAK ITINERANT FERROMAGNETS: APPLICATION TO $ZrZn_2$. Wohlfarth, E. P. (Imperial Coll. of Science and Tech., London). J. Appl. Phys., 39: 1061-6(Feb. 1, 1968).

The itinerant electron model is considered in the limit of very low exchange splitting energies. Magnetic isotherms giving M(H,T) are derived to cover a wide range of fields and temperatures. The isotherms are transformed so as to show that plots of M^2 vs H/M at different temperatures give parallel straight lines. The differential susceptibility below and above the Curie temperature is derived as a function of T. The free energy corresponding to this model is calculated and several results concerning the specific heat of very weak itinerant ferromagnets are deduced. Some properties related to spin-wave excitations are also considered. New experimental data on the material $ZrZn_2$ are considered on the basis of the theory and shown to be in reasonable agreement with it. Several characteristic parameters of this material are deduced, for example a value of the exchange splitting energy 0.040 eV, and of the effective interaction between the itinerant electrons 0.35 eV. The occurrence of very weak itinerant ferromagnetism in other substances is also discussed. (auth)

15596 MAGNETIC PROPERTIES OF THE INTERMETALLIC COMPOUNDS $Dy_xY_{1-x}Fe_2$. Piercy, A. R.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Appl. Phys., 39: 1096-7(Feb. 1, 1968).

Measurements of the bulk magnetization have been made between 4.2°K and the Curie points for eleven compounds in the series $Dy_xY_{1-x}Fe_2$. The Curie temperatures increase continuously through the series. The compounds near to x = 0.3 to 0.4 exhibit temperature compensation points, and the saturation moments show that the equilibrium concentration occurs at $x \simeq 0.28$. In addition, the coercivity increases rapidly in this region and has a value in excess of 10 kOe at x = 0.35, T = 4.2°K. If both the Fe and Dy moments remain constant or vary linearly through the series, the equilibrium concentration would occur at $x \simeq 0.35$. Consideration of the results of these and other similar compounds indicates that the Fe moment varies nonlinearly with x. It is suggested that the Fe moment is approximately 1.4 μ_B for $x < \frac{1}{3}$ and increases gradually for larger x to about 2 μ_B. It is further proposed that this behavior may be explained by the presence of a shallow minimum in the density-of-states curve, sufficient to stabilize the moment for $x < \frac{1}{3}$, but such that the increased coupling allows the moment to increase for higher Dy concentrations. The Fe moments in other $ReFe_2$ compounds are correlated with this model, taking the Curie temperatures as a measure of the exchange energies. (auth)

15597 ESR IN GADOLINIUM–GROUP V COMPOUNDS. Allenson, M. B.; Taylor, K. N. R. (Univ. of Durham, Eng.). J. Appl. Phys., 39: 1094-5(Feb. 1, 1968).

Exchange-narrowed paramagnetic resonance lines have been observed in GdP, GdAs, GdSb, and GdBi, at 9.3 GHz over the temperature range 17 to 400°K. The exchange parameter derived from the linewidth by the theory of Anderson and Weiss has been expressed as a combination of nearest-neighbor superexchange and a temperature-dependent term. This latter term shows good agreement with the theory of Karpenko and Berdyshev and indicates that the predominant exchange, over the temperature range examined, is an indirect interaction via the impurity semiconductor current carriers. In all the compounds the impurity level excitation energy is found to be about 10^{-2} eV. (auth)

15598 MAGNETIC BEHAVIOR OF COBALT AND OF NICKEL IN COMPOUNDS WITH RARE EARTH METALS. Lemaire, R. (CNRS, Grenoble, France); Paccard, D.; Pauthenet, R.; Schweizer, J. J. Appl. Phys., 39: 1092-3(Feb. 1, 1968).

The value of the intrinsic magnetic moment of cobalt in intermetallic compounds of the formula R_xCo_y, where R is a rare earth element or yttrium, is discussed. The experimental values of this moment are determined from the results of neutron-diffraction studies and those of measurements of the absolute saturation magnetization on certain compounds: R_2Co_{17}, RCo_5, R_2Co_7, RCo_3, and RCo_2. The electronic configuration of cobalt is greatly modified both by the addition of the conduction electrons of the rare earth atoms or yttrium and by the magnetic interations resulting from these atoms. This behavior of cobalt permits the explanation of certain apparent anomalies in the properties of the alloys, viz., the differences between the Curie temperatures of the compounds of the same series are too large to be attributable to the interactions between the rare earths alone; the magnetizations and Curie temperatures of the alloys with cerium are smaller than those of the corresponding compounds with yttrium; and certain compounds RCo_2 present a ferrimagnetic–paramagnetic first-order transition. The variation of the Curie temperatures of the compounds R_xNi_y, as a function of rare earth percentage, can be explained by the behavior of the moment of nickel analogous to that of cobalt. (auth)

15599 CONDUCTION-ELECTRON POLARIZATION IN RARE EARTH–PLATINUM ALLOYS. Vijayaraghavan, R.; Rao, V. Udaya Shankar; Malik, S. K.; Marathe, V. R. (Tata Inst. of Fundamental Research, Bombay). J. Appl. Phys., 39: 1086-8(Feb. 1, 1968).

Nuclear magnetic resonance studies of ^{195}Pt in the rare-earth–platinum intermetallic compounds of the composition RPt_2 and RPt_5 (R ≡ La, Ce, Pr, and Nd) have been made in the temperature range 80 to 300°K. They have the cubic ($MgCu_2$ type) and the hexagonal ($CaCu_5$ type) Laves structures, respectively. In RPt_5 compounds, there are two inequivalent platinum sites and correspondingly, two ^{195}Pt resonances are observed in each compound. The platinum Knight shifts, which are positive, are strongly temperature dependent in all but the lanthanum compounds. The magnetic susceptibilities have been measured in the same temperature range. The Knight shift (K) versus susceptibility curves are straight lines, intersecting the K axis at K_0, corresponding to the lanthanum compounds. The EPR of Gd^{3+} in $GdPt_2$ has been observed and a g value of 1.8735 has been obtained. The paramagnetic Curie temperatures are positive for RPt_2 compounds and negative for the others. The results have been discussed in terms of the RKKY theory and the Anderson–Clogston mixing. Values of J(0) have been obtained for the two sets of intermetallic compounds. (auth)

15600 MAGNETIC PROPERTIES OF SOME RARE EARTH–ALUMINUM ALLOYS. Barbara, B.; Becle, C.; Lemaire, R.; Pauthenet, R. (CNRS, Grenoble, France). J. Appl. Phys., 39: 1084-5(Feb. 1, 1968).

The RAl alloys are orthorhombic; the structure can be described with a trigonal motif similar to a half cell of CsCl. The R_3Al_2 alloys are tetragonal. The magnetic properties of the RAl alloys, where R is any rare earth from Ce to Tm, and those of the R_3Al_2 alloys, with R passing from Gd to Tm, have been measured in fields up to 25 kOe or 60 kOe and at temperatures between 1.4 and 400°K. The RAl alloys, with R from Pr to Tb, order antiferromagnetically at temperature between 20°K (PrAl) and 72°K (TbAl); the magnetic configuration of TbAl has been studied by neutron diffraction; HoAl is ferromagnetic with a Curie point at 26°K; DyAl, ErAl and TmAl exhibit metamagnetism at 4.2°K. Gd_3Al_2 is ferromagnetic with a Curie point at 282°K, close to that of Gd; Dy_3Al_2 shows an antiferromagnetic transition near 20°K in zero field and metamagnetic behavior induced by a field below this temperature; its Curie point is 76°K. All compounds exhibit a Curie–Weiss behavior above their transition points, with a paramagnetic moment close to that of the corresponding free tripositive rare earth ions. (auth)

15601 MAGNETIC PROPERTIES OF THE COMPOUND SERIES $Y(Mn_xFe_{1-x})_2$ AND $Y_6(Mn_xFe_{1-x})_{23}$. Kirchmayr, Hans R. (Univ., Vienna). J. Appl. Phys., 39: 1088-9(Feb. 1, 1968).

The pseudobinary systems $Y(Mn_xFe_{1-x})_2$ and $Y_6(Mn_xFe_{1-x})_{23}$ show complete solid solubility. The magnetization and the susceptibility from 80 to 1500°K have been measured. The Curie temperature and the magnetization are lowered by the addition of Mn to YFe_2 and Y_6Fe_{23} and also by the addition of Fe to Y_6Mn_{23}. No magnetic ordering above 90°K is observed for $Y(Mn_xFe_{1-x})_2$, if $x > 0.6$ and for $Y_6(Mn_xFe_{1-x})_{23}$, if $0.4 < x < 0.8$. The change of the hyperfine fields with temperature is proportional to the magnetization. In $Y(Mn_xFe_{1-x})_2$ compounds a distribution of hyperfine fields determined by Mössbauer measurements is present, which results from the randomly distributed Fe atoms at the neighboring sites. In the $Y_6(Mn_xFe_{1-x})_{23}$ series a twofold hyperfine field distribution is observed, arising from the four nonequivalent lattice sites and from the random distribution of Fe and Mn atoms on these sites. (auth)

15602 CRYSTAL STRUCTURE AND THE LOWER PHASE TRANSITION IN SOLID DEUTERIUM BROMIDE. Sandor, E.; Johnson, M. W. (London Univ.). Nature (London), 217: 541-3(Feb. 10, 1968).

It is known from specific heat measurements that solid DBr undergoes two second order phase transitions, both spread over temperature ranges of several degrees. The lower transition is completed at ~93.5°K and the upper transition at ~120.3°K. This behavior is markedly different from that of solid HBr, which shows three second order transitions. It is considered that interpretations of x-ray powder photographs of solid HBr have been erroneous. Subsequent experimental investigations, using dielectric constant, optical, spectroscopic, NMR, and inelastic neutron scattering techniques led to the conclusion that below the lowest transition region both HBr and DBr have an ordered structure composed of H-bonded zigzag chains. The higher phases were considered to be associated with various kinds of disorder in the orientation of the molecules, and it was thought that the molecules could not rotate freely in any of the solid phases. With

a view to resolving ambiguities, the crystal structure of solid DBr was investigated by x-ray and neutron powder diffraction methods. The results obtained are interpreted as indicating that DBr below the lower transition region is isomorphous with the low temperature phase of DCl, having an ordered crystal structure composed of parallel plane zigzag chains. The crystal structure of DBr in the middle phase between the two transition regions is orientational disordered. In the lower transition region DBr forms a mixed crystal, the two components of which are the ordered low temperature and the disordered middle phases. The composition of the mixed crystal varies continuously with temperature and the two components are miscible in all proportions. The crystal structure of DBr in the lower transition region is thus that of a substitutional solid solution of two types of DBr molecules. A conspicuous feature of all x-ray powder photographs taken in the 86 to 118°K range is blurring of the medium and high angle lines, probably due to mechanical strains in the specimen. Although the x-ray and neutron diffraction studies described refer to DBr, the experimental evidence suggests that the results obtained are applicable also to the lower transition region of HBr. (UK)

15603 APPLICATIONS OF THE MOESSBAUER EFFECT TO SILICATE MINERALOGY. I. IRON SILICATES OF KNOWN CRYSTAL STRUCTURE. Bancroft, G. M.; Maddock, A. G.; Burns, R. G. (Cambridge Univ., Eng.). Geochim. Cosmochim. Acta, 31: 2219-46(Nov. 1967).

Moessbauer parameters are reported for a number of silicates of known crystal structure, containing high-spin iron in a range of co-ordination symmetries. The spectra are fitted by computer to Lorentzian line shapes and the component peaks in each spectrum are assigned to the various positions in the particular silicate structure. The results show that the chemical shift and the quadrupole splitting are sensitive not only to the oxidation state and electronic configuration, but also to the co-ordination number and site distortion. An attempt is made to relate the changes in quadrupole splitting to structural features for the six-co-ordinate Fe^{2+} species. Line broadening in such iron compounds is discussed. (auth) (UK)

15604 INFORMATION ON ANODIC OXIDES ON VALVE METALS: OXIDE GROWTH AT CONSTANT RATE OF VOLTAGE INCREASE. Dunn, C. G. (General Electric Research and Development Center, Schenectady, N. Y.). J. Electrochem. Soc., 115: 219-26(Feb. 1968).

The formation of nonporous anodic oxide films is treated mathematically for the constant rate of voltage increase method to provide a basis for interpreting reanodization current–voltage curves. Illustrative reanodization I–V curves are considered for such initial anodic oxide films as nonporous oxide, porous Al_2O_3, plastically deformed Al_2O_3 and Ta_2O_5, and annealed nonporous Al_2O_3. Evidence obtained for pore filling in and the conversion of a porous film into a nonporous film is supported by electron microscopy and thickness measurements. Confirmation of low ductility in Al_2O_3 and high ductility in Ta_2O_5 is obtained. Information is provided on the restoration of ionic conductivity in Al_2O_3, which is lost by annealing. (auth)

15605 ANODIC FILMS, PROTONS, AND ELECTROLYTIC RECTIFICATION. Vermilyea, D. A. (General Electric Research and Development Center, Schenectady, N. Y.). J. Electrochem. Soc., 115: 177-80(Feb. 1968).

Anodic films contain many flaws which for thick films are the sites of electrolytic rectification. For Ta_2O_5 and Nb_2O_5 films below 1000 Å in thickness, however, bulk conduction also occurs. For such films the capacitance also increases markedly on polarization in the forward direction (base metal negative). One interpretation of the capacitance changes involves a proton space charge in the film. The relation between capacitance change and current flow is examined in some detail, and it is shown that there is not a good correlation between the two effects; it therefore appears that two separate phenomena are involved. Possible interpretations are discussed. (auth)

15606 IONIC TRANSPORT IN AMORPHOUS OXIDES. Doremus, R. H. (General Electric Research and Development Center, Schenectady, N. Y.). J. Electrochem. Soc., 115: 181-6 (Feb. 1968).

To aid in understanding the electrical conductance of amorphous oxide films, some experimental and theoretical results on ionic transport in bulk oxide glasses are reviewed. Results on alkali and hydroxyl ion movement in fused silica are perhaps the most pertinent; results on other glasses help to test theories and to show the effects of additives and hydration of the glass. (auth)

15607 CONDUCTION AND STOICHIOMETRY IN HEAT-TREATED, ANODIC OXIDE FILMS. Smyth, D. M.; Shirn, G. A. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 115: 186-92(Feb. 1968).

The dielectric properties of heat-treated, anodic oxide films on certain valve metals can be explained by an exponential gradient of conductivity which decreases monotonically from the metal/metal oxide interface. Evidence is presented that the activation energy of this conduction process is a function of the conductivity. An analysis of the bias dependence of capacitance is presented which indicates that the donor distribution across the heat-treated oxide also depends exponentially on position. These observations are discussed in terms of specific conduction models. (auth)

15608 DEPENDENCE OF MAGNETOSTRICTION AND COERCIVITY ON PROCESS VARIABLES FOR ROLLED 4-79 MOLYBDENUM PERMALLOY TAPE. Vanskike, L. L. (Bell Telephone Labs., Inc., Allentown, Pa.); Chin, G. Y. J. Appl. Phys., 39: 612-13(Feb. 1, 1968).

In certain device applications, it is necessary to obtain cold-rolled Permalloy tape having a high squareness ratio, a very low magnetostriction, and a low coercive force. These properties have been achieved in 4–79 molybdenum Permalloy by discrete variations in processing. A wire is first annealed at a selected diameter, and then cold-drawn to a final diameter followed by roll-flattening. Increasing the anneal temperature (in the 650 to 950°C range) and the extent of cold drawing (prior to flattening) by increasing the anneal diameter, generally results in lower tape H_c. However, as the extent of cold-drawing is increased beyond about 75% area reduction, increased anneal temperatures cause a slight increase in tape H_c. Further, the discrete process variations bring about an optimum two-component tape texture ($\langle 111 \rangle + \langle 100 \rangle$ along tape axis) for zero magnetostriction. However, this optimum texture also depends critically on composition. Compositional deviations of 1% (well within commercial tolerances for 4–79 molybdenum Permalloy) have been found unacceptable in device applications. (auth)

15609 ELECTRICAL RESISTIVITY AND ANTIFERROMAGNETISM IN BINARY CHROMIUM ALLOYS WITH MOLYBDENUM AND TUNGSTEN. Arajs, Sigurds (United States Steel Corp., Monroeville, Pa.). J. Appl. Phys., 39: 673-4(Feb. 1, 1968).

Electrical resistivity has been studied as a function of temperature between 4 and 325°K on two series of binary chromium alloys containing 0.6, 1.6, 3.2, 5.1, 6.9, or 8.8 at. % molybdenum and 0.3, 0.7, 1.0, or 3.4 at. % tungsten. These studies show that the Néel temperature T_N decreases linearly with increasing molybdenum or tungsten concentrations with slopes of about 14°K/at. % Mo and 29°K/at. % W. These decreases of T_N are understandable from the viewpoint of the recent theory by Fedders and Martin and the Fermi surface calculations by Lomer and Loucks. The larger lowering of T_N by tungsten than by molybdenum can be related to its less pronounced localization of d electron wave functions. The contribution to the electrical resistivity due to 1 at. % molybdenum or tungsten in solid solution in chromium is 0.8 and 1.1 μΩ-cm, respectively. The samples containing 3.4 at. % tungsten and 6.9 at. % molybdenum exhibit a minimum in the electrical resistivity–temperature curves at low temperatures. It is suggested that this minimum results from the Kim effect. (auth)

15610 ENHANCED EFFECTIVE EXCHANGE INTERACTION DUE TO LOCALIZED SPINS IN DILUTE ALLOYS AND RARE EARTH METALS. Kim, D. J. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 702-3(Feb. 1, 1968).

An effective interaction between conduction electrons is obtained by eliminating the exchange interaction between conduction electrons and localized spins in metals both in the paramagnetic and spin-ordered state. In the paramagnetic state the effective electron interaction is mediated by the flipping motion of the localized spin under the action of the local field and the electron interaction derived is of an exchange type and repulsive in the vicinity of the Fermi surface. On this basis it is shown that the observed ferromagnetism in dilute alloys like Fe in Pd may be understood from the large enhancement of conduction-electron susceptibility. In the spin-ordered state, such as rare-earth metals below the Curie temperature, the effective electron interaction arises from the exchange of spin waves between electrons. The electron interaction obtained is a form of repulsion between electrons of opposite spins at the same atomic site in the vicinity of the Fermi surface. The electron self-energy due to this effective electron interaction is calculated for a simplified model and the possibility of an appreciable enhancement of the electronic specific heat in rare earth metals is discussed. (auth)

15611 MAGNETIC SUSCEPTIBILITY OF $(U_{1-c}Th_c)O_2$. Comly, J. B. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. 39: 716-18(Feb. 1, 1968).

The magnetic susceptibility χ of UO_2 diluted by its diamagnetic isomorph, ThO_2, is reported for $1.7° \leq T \leq 60°K$. In dilute sam-

ples, 5 to 10% UO_2 in ThO_2, χ^{-1} decreases monotonically with decreasing temperature. Blume's singlet ground-state mechanism for the first-order magnetic phase transition in UO_2 requires a Γ_1 singlet ground state 50°K below a Γ_5 triplet. The crystal-field structure of U^{4+} in ThO_2 should be similar and should lead to a rise in χ^{-1} at low temperature as the triplet depopulates, in striking contrast with observation. Concentrated samples with 0 to 40% ThO_2 in UO_2 show a linear dependence of T_N on concentration, with a critical concentration of 42% ThO_2. The singlet ground-state mechanism in the molecular field approximation predicts that T_N is sharply nonlinear with dilution of the molecular field and falls steeply to zero when diluted by 14%. It is apparent from these two lines of evidence that the static ground state in UO_2 is not a singlet. The first-order transition in UO_2 is probably related to a dynamic lattice interaction, which opposes ordering down to 30°K where a cooperative lattice and magnetic transition takes place. (auth)

15612 ULTRASONIC ATTENUATION AT THE MAGNETIC-PHASE TRANSITION IN GADOLINIUM. Luthi, B.; Pollina, R. J. (Rutgers, State Univ., New Brunswick, N. J.). J. Appl. Phys., 39: 718-19(Feb. 1, 1968).

Ultrasonic attenuation measurements in the vicinity of the Curie temperature are presented. Longitudinal waves along the c axis exhibit a large critical attenuation, whereas transverse waves show only a spurious attenuation peak. Along the a axis the critical attenuation for longitudinal waves is much smaller. In a nonsymmetry direction both longitudinal and transverse waves show large critical attenuation. All these results can be explained, assuming the spin–phonon coupling is of the volume magnetostrictive type. For longitudinal waves propagating either along the c or a axis the following attenuation law is found: $(T - T_C)/T_C > 1 \times 10^{-3}\ \alpha \propto \omega^2(T - T_C)^{-1.5}$. (auth)

15613 INFLUENCE OF NEUTRON AND ARGON ION BOMBARDMENT ON THE INDUCED UNIAXIAL ANISOTROPY IN NONMAGNETOSTRICTIVE PERMALLOY FILMS. Roth, M.; Anagnostopoulou-Konsta, A.; Pauleve, J. (Centre d'Etudes Nucleaires, Grenoble, France). J. Appl. Phys., 39: 738-40 (Feb. 1, 1968).

Technical magnetic thin films evaporated at 150°, 300°, or annealed at 550°C were bombarded by pile neutrons and 11-keV argon ions in a magnetic field at 200°C. After a sufficiently long bombardment time the uniaxial anisotropy constant attains for all films the same saturation value. The experimental data are well explained by supposing this value to be due to the simultaneous presence of directional pair ordering and partial long-range Ni_3Fe-type order. Long-range order seems to exist already in films deposited at 300°C while in the other cases it is created during bombardment. Films condensed at 150°C show an extra component of magnetic anisotropy, probably due to the ordering of lattice imperfections, which disappears during bombardment or annealing. Comparison of the saturation values of induced anisotropy obtained after neutron and argon-ion bombardment shows that the degree of atom-pair order obtained, decreases with increasing number of displacement per second and per atom of the target. (auth)

15614 ORBITAL EFFECTS ON EXCHANGE INTERACTIONS. Elliott, R. J.; Thorpe, M. F. (Oxford Univ.). J. Appl. Phys., 39: 802-7(Feb. 1, 1968).

Many magnetic materials contain ions in which the orbital contribution to the magnetic moment is important. This is normally the case in the rare earths and the actinides, where there is strong spin–orbit coupling and weak crystal fields, and it also occurs in transition metal ions like Fe^{2+} and Co^{2+}. This orbital contribution leads to asymmetric charge clouds and the corresponding asymmetry of the transfer and overlap integrals means that the exchange interaction between pairs of such ions is not of the Heisenberg form but contains more complicated functions of the angular momentum operators. The microscopic form of the exchange and coulomb interaction between pairs of electrons is considered in the single-electron representation and transformed to the (L,S) and J representations of many-electron atomic states, and finally to a pseudospin representation that spans the lowest-lying atomic states in the presence of crystal fields. The symmetry restrictions on this pseudospin Hamiltonian are considered. Detailed calculations are made of a model of UO_2 using Anderson's kinetic exchange mechanism. (auth)

15615 EPR AND MAGNETIC SUSCEPTIBILITY IN SOLID SOLUTIONS OF RARE EARTHS IN NOBLE METALS. Hirst, L. L.; Williams, Gwyn; Griffiths, D.; Coles, B. R. (Imperial Coll. of Science and Tech., London). J. Appl. Phys., 39: 844-6(Feb. 1, 1968).

Susceptibilities were measured and EPR was sought in solutions of 1 at. % or less of the elements of the second half of the 4f series in silver or gold, in order to study local moments on the rare earth ions. EPR lines have been found in AgEr, AuEr, and AuYb. The departures from Curie's law found in the susceptibilities, and the positions (or absences) of EPR lines can be understood and fitted primarily in terms of crystal-field effects. In some of the more concentrated alloys impurity–impurity interaction effects are seen. The temperature-dependent part of the EPR linewidth in 0.28 at. % ErAg corresponds to an exchange coupling $|J_{s-f}| = 0.15$ eV. (auth)

15616 MAGNETIZATION OF SOME SINGLE-CRYSTAL ALLOYS OF RARE EARTH METALS. Bozorth, R. M. (IBM Watson Research Center, Yorktown Heights, N. Y. U. S. Naval Ordnance Lab., Silver Spring, Md.); Gambino, R. J.; Clark, A. E. J. Appl. Phys., 39: 883-5(Feb. 1, 1968).

Single crystals have been prepared of rare earth hexagonal solid solutions having 4f electron concentrations (10 to 11) near which the Stevens' factors change sign. Compositions are Ho_3Er, HoEr, $HoEr_3$, DyEr, and $DyEr_3$. Moment measurements have been made on spheres in the a, b, and c directions (a⊥b⊥c) at 4.2° in fields to 140 kOe. From the data can be derived the cone angles in the ferromagnetic structures, the breakdown of the cone structure (when H⊥c), the approach to saturation against anisotropy forces, and the field strengths at which fanning occurs when H || a or || b. The cone angles so determined are a linear function of the 4f electron concentration, in agreement with neutron-diffraction data. In Ho_3Er the b direction is the easiest in the ab plane, as in Ho, whereas in HoEr and $HoEr_3$ a is easier than b. When H⊥c in Ho_3Er, the moment approaches saturation smoothly against anisotropy forces, whereas in others fanning occurs in a more complicated manner. (auth)

15617 RARE EARTH METAL SINGLE CRYSTALS. II. MAGNETIC PROPERTIES OF Tm, Eu, Sm, AND Yb. Schieber, M.; Foner, S.; Doclo, R.; McNiff, E. J. Jr. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 885-6(Feb. 1, 1968).

Magnetic-moment measurements are presented for single-crystal Tm, Eu, Sm, and Yb along principal axes. The 4.2°K data for Tm and Eu extend to 140 kG, and the Sm and Yb results, at low field, range from 4.2° to ~300°K. Almost complete ferromagnetic alignment in Tm is attained for 140 kG along the [10$\bar{1}$0] direction. A value of almost 7 μ_B is observed. Eu is antiferromagnetic, shows a linear variation of σ vs B_0 up to 140 kG (in disagreement with earlier data), and appears to be isotropic. The susceptibility for Yb shows a small isotropic paramagnetic component, possibly caused by impurities. Single-crystal data show that Sm is a uniaxial antiferromagnet with spins aligned along the c axis and $T_N = 14$°K. (auth)

15618 EXCHANGE INTERACTIONS AND THE SPIN-WAVE SPECTRUM OF TERBIUM. Goodings, D. A. (Univ. of Sussex, Eng.). J. Appl. Phys., 39: 887-8(Feb. 1, 1968).

The spin-wave spectrum of terbium obtained by Møller and Houmann by inelastic neutron scattering at 90°K has been analyzed on the basis of a model consisting of Heisenberg exchange and axial and hexagonal crystal-field terms. By examining the conditions required to fit the calculated spin-wave energies to the experimental results at certain points of high symmetry in the Brillouin zone, values were found for the interatomic exchange constants J_{ij} extending out to sixth-nearest neighbors. These provide a convenient interpolation scheme for obtaining the spin-wave energies throughout the Brillouin zone. The effect of interactions among spin waves arising from the strong crystal-field terms has also been studied. With the aid of an approximation often employed in spin-wave studies of magnetic anisotropy, it was found that the crystal-field parameters of the noninteracting case become multiplied by appropriate powers of the reduced magnetization. This accounts for about half of the temperature dependence of the spin-wave energies measured by Møller and Houmann. (auth)

15619 RARE EARTH METAL SINGLE CRYSTALS. I. HIGH-FIELD PROPERTIES OF Dy, Er, Ho, Tb, and Gd. Rhyne, J. J. (U. S. Naval Ordnance Lab., Silver Spring, Md.); Foner, S.; McNiff, E. J. Jr.; Doclo, R. J. Appl. Phys., 39: 892-3(Feb. 1, 1968).

Magnetic-moment measurements have been made along principal axes of Dy, Er, Ho, Tb, and Gd single crystals at 4.2°K and dc fields to 150 kOe. Dy and Tb showed similar magnetic properties. Saturation along the easy axis was achieved at low fields, while along the hard (c) axis the moment was nearly linear with field and did not approach saturation. Anisotropy was observed in the basal plane at low fields. An irreversible change in Dy and Tb occurred below 150 kOe for fields along the hard axis, such that subsequently saturation could not be achieved along the easy axis.

Extrapolation of the low-field (unstrained) data along the hard axis indicated anisotropy energies of about 10^9 ergs/cm^3. In Er significant modifications of the zero-field conical moment state were observed and theoretical saturation was almost achieved along the c axis. Fields applied in basal-plane directions collapsed the conical state and produced fan-moment distributions approaching saturation near 150 kOe. (auth)

15620 EFFECT OF HYDROSTATIC PRESSURE ON MAGNETIC PROPERTIES OF Tb AND Dy. Tatsumoto, E.; Fujiwara, H.; Fujii, H.; Iwata, N.; Okamoto, T. (Hiroshima Univ.). J. Appl. Phys., 39: 894-5(Feb. 1, 1968).

Measurements of weak-field ac susceptibilities have been made on Tb and Dy under hydrostatic pressures up to about 6 kbar, to investigate the pressure effects on the magnetic transition temperatures, and on the effective number of Bohr magnetons n_{eff} in the paramagnetic state. In addition, the compressibility necessary for the correction was measured. In the paramagnetic temperature range, the measured susceptibilities followed the Curie–Weiss law well, and n_{eff} decreased with pressure; $(1/n_{eff})(dn_{eff}/dp)$ is -9.6×10^{-7} bar^{-1} for Tb and -6.1×10^{-7} bar^{-1} for Dy. These negative values simply suggest the transition of electrons from the 4f shell to the conduction band with decreasing atomic distance. An anomaly in the compressibility was observed at the magnetic transition temperatures in agreement with the thermodynamical Ehrenfest relation for a second-order transition. (auth)

15621 MAGNETIC PROPERTIES OF URANIUM COMPOUNDS WITH NaCl STRUCTURE. Grunzweig, J.; Kuznietz, M. (Israel Inst. of Tech., Haifa). J. Appl. Phys., 39: 905-7(Feb. 1, 1968).

A model is proposed to account for the properties of uranium compounds UX, where X is either an element of the VA group (N, P, As, Sb; Uv compounds) or of the VIA group (S, Se, Te; Uvi). Uv compounds are antiferromagnetic, while Uvi are ferromagnetic. All have high transition temperatures (50 to 220)°K and low electrical resistivities. It is assumed that uranium is in the U^{4+} state ($^3H_4$ configuration) both in Uv and Uvi compounds and the 5f electrons are strongly localized. The X anions are triply ionized in Uv compounds, and doubly in Uvi. The surplus electrons form a conduction band. The U ions are treated by the methods of crystal field theory. The coupling between them is via the RKKY mechanism. The coupling constant is calculated to be in the range of 12 to 22 eV Å^3. In the octahedral field present the $^3H_4$ multiplet splits, so that the ground state is a singlet. The observed saturation moment depends on the relative strength of the crystal field and the exchange interaction. The crystal-field splittings derived are in the range 500 to 1200 cm^{-1}. The model accounts for the observed types of magnetic ordering. The assumptions used are justified briefly. (auth)

15622 TEMPERATURE DEPENDENCE OF THE Eu^{3+} SPIN [S(T)] IN EuP. Jones, E. D. (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 39: 1090-1(Feb. 1, 1968).

The temperature dependence of the Eu^{3+} spin $\langle S(T)\rangle$ in the NaCl-type intermetallic compound EuP has been studied by the observation of the phosphorus nuclear magnetic resonance (NMR) between 100° and 600°K. The phosphorus Knight shift consists of two contributions: (1) a temperature-independent term K_0 equal to the Knight shift in the nonmagnetic isomorph LaP and (2) a temperature-dependent term K(T), proportional to the Eu^{3+} spin $\langle S(T)\rangle$. The temperature dependence of the Eu^{3+} spin $\langle S(T)\rangle$ was calculated for a Eu^{3+} ion in an octahedral crystal field and an exchange interaction of the form $2\beta H_{ex} S(H_{ex} = \lambda\langle S\rangle)$. Good agreement between the calculated and observed temperature dependence of the Knight shift was obtained for E_1 (the energy separation between the J = 0 and J = 1 states) and λ in the range $E_1/k = 525$°K, $\lambda\beta/k = 0$°K to $E_1/k = 475$°K, $\lambda\beta/k = 5$°K. An analysis of the Knight shifts showed that these data are relatively insensitive to the effects of the crystal-field interaction. The uniform-conduction electron spin-polarization model for the Knight shift was used to calculate the resulting s-f exchange energy for EuP to be $J_{sf} \simeq -0.37$ eV, in good agreement with the other rare-earth phosphides. (auth)

15623 MAGNETIC ANISOTROPIES IN ANTIFERROMAGNETIC RARE EARTH ANTIMONIDE SINGLE CRYSTALS. Busch, G.; Vogt, O. (Eidgenoessische Technische Hochschule, Zurich). J. Appl. Phys., 39: 1334-5(Feb. 1, 1968).

The magnetic properties of the rare earth antimonides are anisotropic below ordering temperatures. In the compounds of Ce, Nd, Dy, and Ho the crystalline field confines the spin to the [100] axis. The observed uniaxial metamagnetism is explained in terms of the Ising model. The induced magnetic moments depend strongly on the direction of the applied field. This anisotropy is less pronounced in the cases of TbSb and ErSb, in good agreement with theoretical considerations. Metastable spin structures are observed in DySb, HoSb, and CeSb. (auth)

15624 MAGNETIC ANISOTROPY OF RARE EARTH METALS. Bly, P. H. (Simon Fraser Univ., Can.); Corner, W. D.; Taylor, K. N. R.; Darby, M. I. J. Appl. Phys., 39: 1336-8(Feb. 1, 1968).

Torque measurements have been made to determine K_1 on single crystals of Tb, Dy, and Ho. This constant has been measured as a function of field and temperature in the antiferro- and paramagnetic regions. For Dy and Ho, κ_1 decreases with decreasing T between T_N and T_C, changing sign in Ho and becoming large and negative again when ferromagnetism appears. The results are used to estimate critical fields, which agree well with those derived from magnetization measurements. In the paramagnetic region $K_1 = \beta H^2$ as predicted by Callen and Callen and $\beta \propto (T - T_C)^{-2}$ where T_C is the paramagnetic Curie temperature. The basal plane constant, K_4, has also been obtained for Gd, Tb, and Ho. There is no detectable anisotropy above T_C. For Gd the value of K_4 varies with T as $(\sigma/\sigma_0)^{21}$ and for Tb a good fit is obtained with a function of the form $I_{10}[L^{-1}(m)]$ as suggested by Callen and Callen. The magnitude of K_4 extrapolated to 0°K for Gd is −800 erg/g; the value for Tb is about 500 times larger. A twelvefold symmetry is obtained with Ho and a further constant, K_5, is required to describe the results. (auth)

15625 MAGNETISM AND CRYSTAL STRUCTURE OF ZIRCONIUM COMPOUND WITH LAVES STRUCTURE. Kanematsu, K. (Nihon Univ., Tokyo). J. Appl. Phys., 39: 465-6(Feb. 1, 1968).

Magnetic studies were performed on intermetallic compounds with Laves-type structure, $(Zr, Nb)Fe_2$, $(Zr, Mo)Fe_2$, $Zr(Fe, Mn)_2$, $Zr(Fe, V)_2$, and $Zr(Fe, Co)_2$. The crystal structure of all the compounds except $Zr(Fe, Co)_2$ changes from the $MgCu_2$ type to $MgZn_2$ type with decreasing $ZrFe_2$ content. The magnetism changes from ferromagnetism to paramagnetism with change from $MgCu_2$ type to $MgZn_2$ type, and it is concluded that the $MgCu_2$ structure favors ferromagnetism and $MgZn_2$ structure does not. $Zr(Fe,Co)_2$ has a $MgCu_2$ structure over the entire composition range and the magnetism changes from ferromagnetism to paramagnetism with decreasing $ZrFe_2$ content. (auth)

15626 INDIRECT NUCLEAR SPIN RELAXATION IN HEAVY RARE EARTH METALS. Sherrington, D. (Univ. of Manchester, Eng.). J. Appl. Phys., 39: 502-3(Feb. 1, 1968).

Relaxation through the Suhl–Nakamura effect is investigated in some heavy rare earth metals. Basal-plane ferromagnets have large magnon energy gaps and perturbation theory leads to estimates for the low-temperature relaxation that are not explicitly temperature dependent. Numerical estimates in Tb, Dy are found to be in reasonable agreement with experiment. In spiral structures the unperturbed magnons have no gap and account is taken of the strong coupling of low-momentum nuclear and electronic spin modes leading to temperature-dependent expressions for an effective gap and for the relaxation. (auth)

15627 NUCLEAR MAGNETIC RESONANCE IN PALLADIUM–SILVER ALLOYS. Narath, Albert (Sandia Corp., Albuquerque, N. Mex.). J. Appl. Phys., 39: 553-5(Feb. 1, 1968).

The ^{109}Ag NMR has been studied in a series of $Pd_{1-x}Ag_x$ alloys by spin-echo techniques in external fields near 55 kOe and at temperatures of 1° to 4°K. Knight shifts (K), spin–lattice (T_1), and spin–spin (T_2) relaxation times were determined for 12 compositions in the range $0.025 \le x \le 1$. The shifts are negative for $x \le 0.35$. From the observed lineshape in the x = 0.025 alloy (K = −1.41%) it is estimated that K = −1.46% in the limit of infinite dilution. After adjustment for an estimated direct contact shift of +0.34%, this value yields a hyperfine field of $-140(\pm 10)$ kOe/μ_B of palladium d-spin magnetization, which presumably arises from spin polarization of the s conduction electrons by the palladium host. This process is found to be ineffective as a spin–lattice relaxation mechanism. The observed relaxation times T_1T increase gradually from a value of 9.6(±0.5) sec · °K for pure silver to a broad maximum of 26(±3) sec · °K near x = 0.3 and remain nearly constant at lower concentrations [T_1T = 22(±4) sec · °K for x = 0.025]. The variation of $(T_1T)^{-1/2}$ with composition is qualitatively consistent with the expected variation of the s electron density of states at the Fermi level. The ^{105}Pd spin–lattice relaxation times in palladium metal have been remeasured with the result $T_1T = 0.7(\pm 0.2)$ sec · °K. (auth)

15628 THERMAL EXPANSION AND FORCED MAGNETOSTRICTION IN A TERBIUM SINGLE CRYSTAL. Alberts, L.; du Plessis, P. de V. (Univ. of the Orange Free State, South Africa). J. Appl. Phys., 39: 581-2(Feb. 1, 1968).

Forced-magnetostriction and thermal-expansion measurements on a terbium single crystal are reported. The isotropic component of the basal-plane forced magnetostriction is evaluated for applied fields between 17,500 and 19,500 Oe. A peak value of -18.5×10^{-6}/Oe is found at 246°K. Large, positive, field-dependent forced-magnetostriction values are obtained along the ⟨0001⟩ axis for

fields applied along the $\langle 10\bar{1}0 \rangle$ axis. The field dependence of the $\langle 0001 \rangle$-axis forced magnetostriction is in agreement with Belov's thermodynamic description in the vicinity of the Curie temperature. A large negative expansion anomaly of -104×10^{-6}/deg is obtained at 224°K. The magnetic component of this strain is identified with the exchange and ordinary magnetostriction, and not only with an ordinary term as was done by Rhyne and Legvold. The large magnetothermal strain of 900×10^{-6} occurring at the Curie point, and the persistence of the anomalous behavior high in the paramagnetic region can be ascribed to the exchange magnetostriction. Using $\langle 000\bar{1} \rangle$-axis forced-strain measurements, a calculation by Belov's method of thermodynamic coefficients yields a value of -47×10^{-6}/deg at the Curie point. (auth)

15629 STUDIES OF CURIE-POINT INCREASES IN EuO. Shafer, M. W.; McGuire, T. R. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys., 39: 588-98(Feb. 1, 1968).

The ferromagnetic transition temperature (T_C) of EuO has been increased from 69° to 135°K by selectively doping to increase the electrical conductivity. Three different chemical systems have been studied: the EuO–Eu, the EuO–Eu–RE_2O_3, and the EuO–RES systems (RE is a rare earth other than europium). Compositions in the latter system were multiphase because the solubility of the rare-earth sulfides in EuO is very small and it was necessary to add about 10% to cause significant Curie-temperature increase. Single crystals have been grown from ternary compositions in the EuO–Eu–RE_2O_3 system with magnetizations at 77°K as high as 170 G cm^3/g and ferromagnetic Curie temperatures (T_C) close to the paramagnetic θ values, a condition not observed in the other doped europium chalcogenides. The effect of the Eu metal on the formation of these crystals and its role in "forcing" the trivalent rare-earth oxide into the rock-salt lattice is discussed. From Kerr measurements and the optical absorption data, it is shown that the magnitude of the rotation of the doped material at 80°K is equal to that of pure EuO at 18°K. This makes this material attractive for use in magneto-optical devices operating at nitrogen temperature. (auth)

15630 INDUCED COLOR CENTERS IN CaF_2 CYRSTALS IRRADIATED WITH NEUTRONS AT LIQUID NITROGEN TEMPERATURE. Kamikawa, Tomoyosi; Ozawa, Kunio (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 24: 115-19(Jan. 1968).

The effect of neutron irradiation at LNT on the color center formation in CaF_2 crystals was investigated. A peculiar absorption band system was obtained. It differs either from the usual four-band spectrum or from the spectrum of the crystals neutron-irradiated at pile temperature. In addition to the bands observed in CaF_2 crystals irradiated with neutrons at pile temperature, appears a band peaking at 580 nm, which grows with increasing neutron dose. The F band could not be observed. Change of the defect state during storage and the effect of temperature rise on color centers are discussed and used for the explanation of the absence of the F band in crystals irradiated at low temperatures. Optical bleaching study shows that the main band at 420 nm is composed of at least two different bands. A band at 535 nm, which is characteristic of neutron irradiation, shows a fine structure at liquid helium temperature. Brief comments are made on the center responsible for this band. (auth)

15631 DEVELOPMENT OF A Co–W FERROMAGNETIC HIGH-TEMPERATURE STRUCTURAL ALLOY. Ashbrook, R. L.; Hoffman, A. C.; Sandrock, G. D.; Dreshfield, R. L. (Lewis Research Center, Cleveland). J. Appl. Phys., 39: 599-600(Feb. 1, 1968).

Rotors for space power generators require a compromise between high-temperature strength and magnetic properties. Rotors must withstand high centrifugal stresses at high temperatures and develop high induction for small exciting fields. Alloys considered for rotors include maraging steels, H-11 steel, and a Co-base alloy, Nivco. This paper discusses work to develop alloys with improved high-temperature strength and good high-temperature magnetic properties. Because Co has the highest Curie temperature of any metal and is a good base for high-temperature alloys, a NASA superalloy Co–25W–1Ti–½Zr–½C was chosen for further study. Modifications of this alloy were screened for magnetic induction (H = 100 Oe) over a range of temperatures. For increasing W, Curie temperature decreased for the base Co–XW–1Ti–½Zr–½C, and B_{max} above 1000°F decreased. Below 1000°F, low-W alloys show B_{max} vs T inflections due to instability of the fcc phase. Stability of the fcc increased with increasing W and Fe. A preferred alloy, Co–7½W–2½Fe–1Ti–½Zr–½C, was evaluated for magnetic and mechanical properties in cast form and for mechanical properties as sheet. After aging at 1700°F for 72 hr, this alloy had a coercive force of 10.5 Oe at 75°F, and a B_{max} of 11.5 kG and 19.3 kG at 1200° and 1400°F, respectively. The stress rupture life at 1200° to 1400°F was greater than that of the strongest high-temperature commercially available magnetic-structural alloy. (auth)

15632 IMPEDANCE FOR TUNNEL EXCHANGE OF ELECTRONS ACROSS THE ANNEALED Ta/Ta_2O_5 INTERFACE. Lehovec, K. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 115: 192-9(Feb. 1968).

Tunneling of electrons from the tantalum metal into the adjacent oxide is an alternative explanation to a conductivity profile for the observed impedance of annealed Ta/Ta_2O_5 capacitors as function of frequency, bias voltage, and temperature. The transformation of the Schottky-distribution $[\partial E/\partial(1/C)]^2$ vs $(1/C)$] into the distribution of recipient sites for tunneling electrons is derived. An explanation for the observed dependence of the activation energy of "conductivity" on position is given. A method is suggested for studying polarization by means of the tunnel impedance. (auth)

15633 STUDY OF GALLIUM GLASSES BY THE EPR METHOD. Yudin, D. M.; Sherstyuk, A. I.; Tsekhomskaya, T. S. Dokl. Akad. Nauk SSSR, 172: 1063-5(1967). (In Russian).

This is a continuation of earlier investigations dealing with EPR spectra of various aluminum, phosphate, and borate glasses in which the lattice nuclei have nonzero spin. Inasmuch as the effective gamma rays on gallium glass has not been investigated before, the authors used a 3-cm radio spectrometer (RE-1301) to investigate gallium glass subjected to prior gamma irradiation from ^{60}Co (dose 10^6 r). Two types of glass, situated on opposite sides of the $Ga_2O_3/Li_2O = 1$ boundary, were tested. There were no resonance lines prior to irradiation. After irradiation, sample No. 1 (16% Li_2O, 12% Ga_2O_3, 72% SiO_2) showed the single resonance line characteristic of all the alkali-silicate glasses, and sample No. 2 (16% Li_2O, 21% Ga_2O_3, 63% SiO_2) showed four equidistant peaks. The latter are interpreted as a hyperfine structure due to the interaction of a paramagnetic trap produced by gamma irradiation with the gallium nucleus. The differences between the two types of glasses are interpreted from the point of view of the differences in the nature of the hole traps produced in the glasses. The level schemes and the bonding schemes of the two glasses are discussed. The absence of resonance lines due to electron traps is probably due to the fact that the alkali metal ions form nonparamagnetic microparticles upon capture of electrons. (ATD)

15634 SOME RESULTS FROM INVESTIGATION OF HIGH-TEMPERATURE ANNEALING OF IRRADIATED N–P TRANSITIONS. Golovner, T. M.; Grigor'eva, G. M.; Kreynin, L. B.; Landsman, A. P. Fiz. Tekh. Poluprov., 1: 964-6(1967). (In Russian).

An investigation was made of the annealing of n–p transitions irradiated with 400-keV and 6.3-MeV protons. The specimens were prepared by diffusing phosphorus into p-conductivity silicon plates alloyed with boron to a concentration of $\sim 10^{16}$ cm^{-3}. The depth of the transition was 1.5 to 2μ. The proton irradiation was conducted from the n-layer side. The curves of the dependence of the accumulation coefficient on the wavelength of the incident light before irradiation, after irradiation with 6.3-MeV proton flux of 10^{12} cm^{-2}, and after holding the irradiated specimen for 30 min at 415°C, show that the increased efficiency in the accumulation of carriers occurs as the result of the increase in the lifetime of the minority carriers τ in the n and p regions and the increase in the diffusion length $L = \sqrt{D\tau}$, where D is the diffusion coefficient of the minority carriers. During annealing, specimens irradiated with 400-keV protons showed a more complete recovery of electron diffusion length than specimens irradiated with 6.3-MeV protons, even though the flux in the first case was an order higher. In case of bombardment with 6.3-MeV protons, the free path of which is larger than the diffusion length in nonirradiated material, the accumulation of carriers occurs from the region with a practically uniform distribution of defects along the depth and the measured value of L_n is the true length of electron diffusion in n-silicon damaged by irradiation. (ATD)

15635 INVESTIGATION OF ISOCHRONOUS AND ISOTHERMAL ANNEALING OF InSb IRRADIATED WITH X AND GAMMA RAYS. Vitovskii, N. A.; Mashovets, T. V.; Khansevarov, R. Yu.; Chelustka, B. (Physical-Technical Inst., Leningrad). Fiz. Tekh. Poluprov., 1: 766-73(1967). (In Russian).

An investigation was made of the transformation of n-InSb into p-InSb under the effect of irradiation and of the reverse transformation during annealing. The irradiation of n- and p-type InSb was carried out at 78°K with gamma rays from a ^{60}Co source and with x-rays with a maximum energy of 55 keV. The dependence of the concentration of current carriers on the duration of x irradiation for p- and n-InSb showed that the irradiation of n-InSb is not accompanied by a variation in electron concentration, while the

irradiation of p-InSb results in an increase in hole concentration. The initial rate of hole generation in p-InSb was $(4 \pm 2) \times 10^{-5}$ cm^{-1}. During isochronous annealing only one annealing stage at 95°K was observed, which showed that only one type of defect was present. The annealing of these defects takes place at 78°K. The energy of annealing activation was 0.27 ± 0.03 eV. By increasing the annealing temperature of p-InSb from 120 to 140°K, a decrease in hole concentration was observed at 78°K to values smaller than the p_0 concentration in the nonirradiated material. With a further increase of annealing temperature up to 170°K, there was a recovery to the p_0 concentration. During gamma irradiation the concentration of electrons in n-type material decreases, while the hole concentration in p-InSb and n-InSb after n–p conversion increases. The initial rates of change of the current carriers in n- and p-InSb are approximately identical and equal to $(6 \pm 2) \times 10^{-3}$ cm^{-1}. With an increase in the irradiation dose, the rate of change of the hole concentration decreases. In p-InSb and InSb converted from n into p, the annealing of irradiation defects was detected at 78°K. The rate of such annealing is 8×10^{-7} sec^{-1}. (ATD)

15636 RECOMBINATION EMISSION IN SILICON SINGLE CRYSTALS IRRADIATED BY FAST NEUTRONS. Bortnik, M. V.; Tkachev, V. D.; Yukhnevich, A. V. Fiz. Tekh. Poluprov., 1: 959-60(1967). (In Russian).

An investigation was made of the spectra of recombination emission in silicon single crystals irradiated by fluxes of fast neutrons. The specimens used in the experiment were made of n-type silicon with a resistivity of 100 ohm · cm. The nonequilibrium carriers were excited by a short-wave light, while the specimens were irradiated by fast reactor neutrons at a temperature of 70°C. The distinctive feature of the emission spectra in the impurity region of the specimens is the presence of a band 0.15 eV wide with a maximum of 0.78 eV (resolution, 0.02 eV). The intensity of the band sharply decreases with an increase in temperature of 90 to 125°K. The impurity bands A (0.967 eV) and B (0.488 eV) were also observed in the spectrum. Based upon the results from the experiment, the following conclusions were reached: (1) Irradiation by relatively weak fluxes of fast neutrons (up to 10^{13} cm^{-2}) and γ quanta leads to development of the same centers of recombination emission, which do not determine the lifetime of nonequilibrium carriers because the annealing of the corresponding impurity bands does not lead to any perceptible restoration of the self-emission band. (2) The difference in the intensity of the emission bands in specimens irradiated by fast neutrons and by γ-quanta (with equal relative drops in the self-emission intensity) is illustrated by the greater development efficiency of centers of recombination nonemission during the neutron irradiation. (3) During irradiation by fast neutron fluxes higher than 10^{15} cm^{-2}, the development speed of the centers (which are responsible for the development of bands A and B is lower than the development speed of centers determining the lifetime of nonequilibrium carriers. This leads to an intensity drop in the impurity bands. (ATD)

15637 INVESTIGATION OF STRUCTURAL DEFECTS IN SILICON SINGLE CRYSTALS IRRADIATED WITH FAST NEUTRONS. Lugakov, P. F.; Tkachev, V. D. (Belorussian State Univ., Minsk). Fiz. Tekh. Poluprov., 1: 681-6(1967). (In Russian).

An investigation was made of (1) the effect of neutron irradiation on the electric and photoelectric properties of p-type silicon crystals and (2) the effect of high-temperature annealing of radiation damage resulting from irradiation by large integral fluxes of fast neutrons. The silicon single crystals were grown in quartz crucibles and had an initial resistivity of 0.03 to 100 ohm · cm. They were irradiated with fast neutrons in an IRT-2000 reactor at a temperature of approximately 70°C. The integral irradiation doses were 1×10^{13} to 5×10^{18} neutron/cm^2. The photoconductivity spectra were taken during excitation with constant and modulated light fluxes (modulation frequency 23.5 cps). The irradiated specimens were subjected to isochronic, isothermic, and "staged" annealing in a vacuum of 10^{-4} mm Hg in a temperature range of 50 to 600°C. The following were obtained: The dependence of the resistivity of p-type silicon crystals on the irradiation dose of fast neutrons, the spectral distribution of the photoconductivity of irradiated specimens, the dependence of the specific electroconductivity at room temperature on the annealing temperature, isotherms of annealing for specimens with initial $\rho = 25$ ohm · cm irradiated with a neutron flux of 5×10^{16} cm^{-2}, the spectral distribution of impurity photoconductivity at room temperature, photoconductivity spectra obtained at liquid nitrogen temperatures for different stages of high-temperature isochronic annealing, and energy states of all defect levels discovered during the investigation of the photoconductivity spectra and temperature dependence of electroconductivity on different stages of annealing. From a comparison of the obtained results with results of work on low-temperature annealing of silicon crystals irradiated with comparatively small fluxes of fast neutrons, it can be seen that the majority of the defect levels seen at low-temperature irradiation and annealing can also be seen at high-temperature irradiation and annealing. (ATD)

15638 EFFECT OF NEUTRON IRRADIATION ON THE ELECTRIC PROPERTIES OF INDIUM ARSENIDE. Savin, E. P.; Boltaks, B. I. (Inst. of Semiconductors, Leningrad). Fiz. Tekh. Poluprov., 1: 937-40(1967). (In Russian).

An investigation was made of the effect of structural defects on the electric properties occurring as the result of fast-neutron irradiation of InAs. An investigation was also made of the kinetics involved in annealing these defects. N-type InAs single crystals with an electron concentration of 2×10^{17} cm^{-3} were used in the experiments. The specimens were irradiated with fast neutrons in the experimental channels of the LFTI reactor. The electric characteristics of the specimens (electroconductivity and Hall effect) were measured before and after irradiation in the temperature range from 100 to 600°K. After irradiation, the electron concentration increased approximately three times; after annealing, it decreased by approximately 1.3 times. As the result of irradiation with a flux of fast neutrons (1.5×10^{17} neutron/cm^2), the p-type InAs was transformed into n-type. Two donor levels are introduced during irradiation: one which is very shallow, almost coinciding with the bottom of the conductivity zone, and another which is 0.4 eV below the bottom of the conductivity zone. The increased electron concentration in n-type InAs and the transformation of p-type InAs into the electron-type show that fast-neutron irradiation leads to the appearance of donor-type structural defects in the material. The electron mobility of n-type specimens after irradiation decreased considerably (from 22,000 to 6400 cm^2/v · sec at room temperature and a flux of 2×10^{17} neutron/cm^2) and after annealing increased (up to 13,000 cm^2/v · sec at the same temperature). After prolonged annealing of both types of irradiated specimens at temperatures greater than 300°C the conductivity and the concentration acquired their initial values. (ATD)

15639 TRACKS OF CHARGED NUCLEAR PARTICLES IN AgCl CRYSTALS. Breuer, K.; Haase, G.; Schopper, E. (Univ., Frankfurt am Main). Brit. J. Appl. Phys., 18: 1824-5(Dec. 1967).

The effects of alpha particles in AgCl crystals leading to tracks that can be rendered visible by "decoration" techniques were found to have in some cases a very short lifetime, which is a function of the structural properties of the crystals and the doping materials used. The formation of visible tracks therefore depends on the time interval between irradiation and decoration. This property could be used for the triggered recording of tracks. (auth) (UK)

15640 TEMPERATURE DEPENDENCE OF THE THRESHOLD OF THE FORMATION OF RADIATION DEFECTS IN SILICON IRRADIATED WITH ELECTRONS. Kolomenskaya, T. I.; Razumovskii, S. M.; Vintovkin, S. I. (Moscow State Univ. Inst. of Physics, Moscow). Fiz. Tekh. Poluprov., 1: 789-91 (1967). (In Russian).

The threshold energy and spatial distribution were determined for the formation of stable defects in silicon irradiated with electrons on a Van de Graaff electrostatic generator at temperatures of 300 and 80°K. The measurements were based on the changes of silicon electroconductivity due to the appearance of radiation defects. At a temperature of 300°K the threshold energy was (145 ± 20) keV, which corresponds to an energy of approximately 13 eV being transferred to the silicon atom. This value is in good agreement with the data given in the literature. At an irradiation temperature of 80°K the threshold energy was (220 ± 30) keV, which corresponds to an energy of approximately 20 eV being transferred to the silicon atom. (ATD)

15641 TEMPERATURE DEPENDENCE OF THE CONCENTRATION AND MOBILITY OF CURRENT CARRIERS IN SILICON ALLOYED WITH BORON AND PHOSPHORUS BY MEANS OF ION BOMBARDMENT. Tetel'baum, D. I. (Gorky State Univ., USSR). Fiz. Tekh. Poluprov., 1: 712-17(1967). (In Russian).

Measurements of the electric conductivity and the Hall effect were used in an investigation of the temperature dependence of the concentration and mobility of current carriers in silicon bombarded by boron and phosphorus ions with an energy of 50 keV at a dose of 10 μcoul/cm^2. Specimens $5 \times 4 \times 0.4$ mm of p-type silicon with a resistivity of 5000 ohm · cm were used. The irradiated specimens were annealed in a dehumidified argon flux at 500 and 700°C for 30 min. (TSS) (ATD)

15642 EFFECT OF ELECTRON BOMBARDMENT ON THE CONDUCTIVITY OF THIN LEAD SULFIDE LAYERS. Artamonov, O. M.; Yudovina, G. A. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 1, 130-1(1967). (In Russian).

The effect of electron bombardment, with an energy range of 20 to 2500 eV, upon the conductivity of thin PbS films evaporated in a

vacuum was studied. The results show that electron bombardment of the layer leads to the desorption of oxygen from the surface of the film if the film is exposed to air at temperatures up to 200°C. The formation of an electrically charged layer on the film surface was observed when the specimen was activated at a temperature of 560 to 600°C before bombardment. (ATD)

15643 ZERO-PHONON LINES AND PHONON COUPLING IN NEUTRON-IRRADIATED MgO CRYSTALS. Nakagawa, Masuo; Ozawa, Kunio (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 24: 96-102(Jan. 1968).

Color centers and zero-phonon lines due to impurities or lattice defects in MgO single crystals irradiated in a reactor at 80°K are reported. A number of sharp absorption bands have been interpreted as a single phonon band and/or two-phonon combination bands involving several characteristic phonon energies. Four characteristics of the zero-phonon lines are investigated experimentally as functions of the temperature; namely, the ratios of the line intensities to their associated broad bands, the shift in the peak position, the half-width and the line shape. The results can be well described in terms of Raman scattering of Debye-model phonons, although different Debye temperatures must be assigned to different zero-phonon lines. (auth)

15644 MOESSBAUER EFFECT STUDY OF SPIN RELAXATION IN $CaFe_2O_4$. Yamamoto, Hisao (Tohoku Univ., Sendai); Okada, Takuya; Watanabe, Hiroshi; Fukase, Masahiro. J. Phys. Soc. Jap., 24: 275-9(Feb. 1968).

Moessbauer effect measurements have been made on $CaFe_2O_4$, an antiferromagnetic oxide which has a magnetic transition at low temperatures. It has been found that the hyperfine splitting due to the internal field for the high temperature magnetic phase is subject to motional narrowing, possibly due to the thermal fluctuation of the spin correlation between weakly interacting antiferromagnetic arrays of Fe and O atoms. (auth)

15645 MOESSBAUER EFFECT IN IRON-CARBON MARTENSITE STRUCTURE. Moriya, Takeshi (Osaka Univ.); Ino, Hiromitsu; Fujita, F. Eiichi; Maeda, Yutaka. J. Phys. Soc. Jap., 24: 60-8(Jan. 1968).

The Moessbauer spectra in iron–carbon martensite could be resolved into four components arising from the 1st, 2nd, (3, 4)th neighboring iron atoms for the carbon atoms and the remnant iron atoms. The carbon atoms were found to cause localized changes of electronic states of the surrounding iron atoms. The internal magnetic field, isomer shift and quadrupole splitting for the first neighbors largely deviated from those for pure iron, i.e., 265 ± 2 kOe, −0.03 ± 0.05 mm/sec and 0.13 ± 0.05 mm/sec, respectively, suggesting the covalent admixture between the iron and carbon atoms. The internal fields and isomer shifts for the 2nd and (3,4)th neighbors also deviated slightly from those of pure iron, but with the sign opposite to those for the 1st neighbors. The quadrupole splittings for them were nearly zero, which mean that the positive charge of a carbon ion is almost screened out within a distance of the order of 2Å. (auth)

Theoretical Physics

Refer also to abstract 15659.

15646 (JINR–E4-3687) DEVELOPMENT OF STATISTICAL INTERPRETATION OF QUANTUM MECHANICS BY MEANS OF THE JOINT COORDINATE-MOMENTUM REPRESENTATION. Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 37p. (In Russian). Dep.

The problem of the determination of a trajectory or probability density in phase space according to the known statistical distributions for momenta and coordinates is considered. For the first time for a typical quantum case of harmonic oscillator motion in the zero state the positive probability has been obtained everywhere in the joint coordinate–momentum representation. The conclusion is drawn that the main peculiarities of microparticle motion (zero energy, uncertainty relation, the tunnel effect and the principally unremovable statistical character of description) are due to the virtual process of interaction with zero oscillations of physical vacuum. (auth)

15647 ON THE CONNECTIONS BETWEEN THE NONLINEARITY OF EQUATIONS OF MOTION IN QUANTUM THEORY, ASYMPTOTIC BEHAVIOR, AND RENORMALIZATION. Aks, Stanley O. (Univ. of Illinois, Chicago). Fortschr. Phys., 15: 661-79(1967).

It is shown that the ordinary perturbation expressions used in quantum mechanics lead to the wrong asymptotic behavior of the Heisenberg observables as function of time. This difficulty is traced to the nonlinearity of the Heisenberg equations of motion and is studied in the context of a one-dimensional nonlinear oscillator problem. It is found that the correct asymptotic behavior can be obtained by a process of renormalization analogous to renormalization theory in quantum field theory. It turns out that the renormalized parameters analogous to mass and wave-function renormalization are not c numbers but are instead q numbers. It is suggested that the renormalization parameters of quantum field theory are also q numbers. (auth)

15648 QUESTIONS OF METHOD IN THE CONSISTENCY PROBLEM OF QUANTUM MECHANICS. Rosenfeld, L. (NORDITA, Copenhagen). Nucl. Phys., A108: 241-4(1968).

Attempts to set up on an axiomatic basis an abstract "theory of measurement" in quantum mechanics lead to imaginary difficulties and suggest speculations about nonphysical effects which have no objective justification. (auth)

15649 COMMENTS ON A RECENT PAPER CONCERNING THE QUANTUM THEORY OF MEASUREMENT. Loinger, A. (Univ., Milan). Nucl. Phys., A108: 245-9(1968).

Recently Jauch, Wigner, and Yanase have published a review article essentially devoted to a discussion of the three papers, in which Daneri, Loinger, Prosperi, and Rosenfeld have given a physical foundation of the quantum theory of measurement, which remains completely within the conceptual domain of present-day quantum mechanics. Unfortunately, a good deal of the opinions expressed in this article on the problem of the quantal measurements is misleading or incorrect, as it is shown. (auth)

15650 SOME GEOMETRICAL PROPERTIES OF THE ELECTROMAGNETIC FIELD. Makhanta, M. H. Vestn. Mosk. Univ., Ser. III, Fiz. Astron., No. 3, 73-8(May-June 1967). (In Russian).

Geometric structure of the electromagnetic field energy–momentum tensor was studied. The main axis of the tensor in four-dimensional space and the expression for covariance of the main axis were analyzed. (R.V.J.)

15651 CHERENKOV RADIATION IN A CYLINDRICAL WAVEGUIDE WITH ELLIPTIC CROSS SECTION. Khan, R. M. (City Coll., Calcutta). Brit. J. Appl. Phys., 18: 1453-7(May 1967).

Cherenkov radiation within a cylindrical waveguide with elliptic cross section due to a particle moving along a line parallel to the axis of the cylinder through one focus is considered. As is usual in waveguide problems, modes of frequencies are obtained; moreover the energy due to radiation concentrates on a line parallel to the axis through the other focus. (auth) (UK)

15652 CHERENKOV RADIATION BY A POINT CHARGE MOVING PARALLEL TO THE PLANE INTERFACE BETWEEN TWO SEMI-INFINITE DIELECTRIC MEDIA. Khan, R. M. (City Coll., Calcutta). Brit. J. Appl. Phys., 18: 1443-51(May 1967).

Cherenkov radiation in two semi-infinite dielectric media due to a point charge moving parallel to the plane interface was calculated as a simple boundary-value problem. The results obtained differ from those of Danos, Linhart and Pafomov but are in complete agreement with the formulae for Cherenkov radiation in an infinite homogeneous dielectric medium and in a semi-infinite homogeneous dielectric medium with the plane conducting boundary as the limiting case. No discrepancy arises on interchanging dielectric constants if the particle moves along the common boundary plane. The result obtained from the radiation formula by a Linhart-type approximation is superior to Linhart's result from the point of view of rigour. (auth) (UK)

15653 DETERMINATION OF THE QUANTUM STATE BY MEASUREMENTS. Gale, W. (Rice Univ., Houston, Tex.); Guth, E.; Trammell, G. T. Contract AT(40-1)-1316. Phys. Rev., 165: 1434-6(Jan. 25, 1968). (ORO-1316-39).

A question raised by Pauli as to whether or not the probability densities in space and momentum determine the wave function is answered negatively. The assertion by Kemble that the probability density and its time derivative determine the wave function is shown to be not generally true. It is shown that measurement of the probability density and the probability current determine the wave function of a spinless particle. The measurement of the probability current is discussed. Measurements which determine the spin state and the density matrix of a mixture are also considered. (auth)

15654 QUANTUM STATISTICAL MECHANICS. Meijer, Paul H. E. Documents on Modern Physics. New York, Gordon and Breach, Science Publishers, 1967. 181p. $9.75 Hardbound, $4.95 Paper.

The course from which these notes were taken was intended for students who had adequate knowledge of quantum mechanics and

statistical mechanics but not of quantum statistical mechanics as well as for researchers who were curious about the workings of the diagrammatical and related methods in quantum statistical mechanics. (W.D.M.)

15655 SOURCES FOR HISTORY OF QUANTUM PHYSICS. AN INVENTORY AND REPORT. Kuhn, Thomas S.; Heilbron, John L.; Forman, Paul; Allen, Lini. Philidelphia, American Philosophical Society, 1967. 189p. $5.00.

A bibliography of literature of primary importance for the historical development of quantum mechanics is presented. (M.O.W.)

15656 FOUNDATIONS OF QUANTUM MECHANICS. Jauch, Josef M. Addison-Wesley Series in Advanced Physics. Reading, Mass., Addison-Wesley Publishing Company, 1968. 310p.

Fifteen chapters are included and deal with the following: (1) mathematical foundations, (2) physical foundations, and (3) elementary particles. (M.O.W.)

15657 EQUILIBRIUM STATISTICAL MECHANICS. Jackson, E. Atlee. Prentice-Hall International Series in Engineering of the Physical Sciences. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1968. 253p. $7.75.

This introduction to equilibrium statistical mechanics covers both classical and quantum aspects for both open and closed systems. A working knowledge of integral calculus is a prerequisite. The first two chapters contain preparatory material which is meant to familiarize the reader with probability and microscopic models of systems before discussing statistical mechanics proper. The final chapter contains sixteen sections, each dealing with a different application, from classical statistical mechanics through degenerate quantum statistical mechanics. (W.D.M.)

15658 INTRODUCTION TO QUANTUM THEORY. Hameka, Hendrik F. New York, Harper and Row, Publishers, 1967. 287p.

This text is designed to teach elementary quantum mechanics to undergraduates in chemistry and physics. The treatment is clear, with detailed attention given to areas where the beginning student is likely to have difficulties. All necessary mathematics, except introductory calculus, are included. Problems are provided. (W.D.M.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 15693 and 15873.

15659 (BNL–50057, pp 3-36) PHYSICS. (Brookhaven National Lab., Upton, N. Y.).

Developments in research in the fields of particle physics, nuclear physics, neutron physics, solid state physics, and theoretical physics from July, 1966 to July, 1967 are outlined. (W.H.K.)

Electromagnetic

Refer also to abstract 15878.

15660 (DESY–67/40) RESONANCES (BUBBLE CHAMBER). Lohrmann, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1967. 73p. Dep.

An account of photoproduction of mesonic and baryonic resonances on protons and neutrons observed in bubble chambers is given. The energies covered the range from threshold to about 6 GeV. The production of various meson and nucleon resonances is considered, and the cross sections are shown. (J.F.P.)

15661 MEASUREMENTS OF THE POLARIZATION OF PROTONS FROM DEUTERON PHOTODISINTEGRATION. Liu, F. F.; Lundquist, D. E.; Wilk, B. H. (Stanford Univ., Calif.). Contract Nonr 225(67). Phys. Rev., 165: 1478-82(Jan. 25, 1968).

The polarization of the proton produced by the photodisintegration of the deuteron was measured at several angles for photon energies between 170 and 450 MeV. The polarization is found to be around −0.20 (Basel convention) for 90° c.m. and photon energies between 200 and 300 MeV. This is in reasonable agreement with a calculation by D. George based upon the Austern model. However, the calculation fails to explain the strong increase in polarization with increasing photon energies. At a photon energy of 450 MeV and 90° c.m. the proton polarization is as large as −0.60. (auth)

15662 π^0 PHOTOPRODUCTION FROM THE DEUTERON AT FORWARD ANGLES IN THE ENERGY RANGE FROM 900 MEV TO 1400 MEV. Clinesmith, Carl Rudolph. Pasadena, Calif., California Inst. of Tech., 1967. 118p.

Thesis.

The cross section for the reaction $\gamma + d \rightarrow \pi^0 + p + n$ was measured. The π^0 was detected by measuring its decay gamma rays with two lead galss, total absorption Cherenkov counters. The results are three angular distributions at k = 911, 1180, and 1390 MeV, at forward angles from 3 degrees to 90 degrees. The deuteron/proton ratio differs significantly from 2.0, but final state effects from the use of a deuteron target make impossible quantitative conclusions about the neutron cross section. (Disser. Abstr.)

15663 SEA-LEVEL COSMIC-RAY SEARCH FOR FAST SMALL-POLE-STRENGTH MAGNETIC CHARGES. Green II, Philip Joseph. Baton Rouge, La., Louisiana State Univ. and Agricultural and Mechanical Coll., 1967. 110p.

Thesis.

The Cherenkov emission for a fast magnetic charge is enhanced by the refractive index squared relative to that for a similar pole strength electric charge, whereas the ionization energy loss is expected to be the same. This experiment distinguished fast magnetic charges by comparing the Cherenkov and scintillation pulse amplitudes from single particles. A Lucite Cherenkov counter ($\frac{1}{4}$ m^2 area) was sandwiched between two plastic scintillation counters and accepted 0.027 steradians. Discriminators accepted only events in which the scintillation pulses matched within 70% to 30% from 0.7× to 2× minimum ionization respectively. The two scintillation counter pulses were added to provide a single measure of the ionization energy loss for comparison with the Cherenkov pulse. Two $\frac{1}{4}$ m^2 side shower counters discriminated against extensive air showers. The two pulse amplitudes were analyzed by a pulse height analyzer and recorded onto paper tape for computer data analysis. Events were displayed as event frequency versus Cherenkov/scintillation pulse amplitude ratio. With the fast charged particle ratio normalized to unity, the fast monopole ratio should be $(1.5)^2$. There were 10,000 events recorded. Treating the Cherenkov/scintillation ratio histogram as a superposition of an electric charge distribution and a magnetic charge distribution yields an upper limit on the flux of magnetic charges from 0.7× to 2× minimum ionization of 4.0×10^{-6} cm^{-2} sec^{-1} ster^{-1}. (Disser. Abstr.)

Weak

15664 (NEVIS–164) SEARCH FOR THE INTERMEDIATE BOSON OF THE WEAK INTERACTIONS. Sunderland, John (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1967. Contract AT(30-1)-1932. 123p. (CU–268; R–605). Dep. CFSTI.

Thesis.

A search for the intermediate boson proposed to mediate the weak interactions was carried out in two experiments performed with the fast extracted beam at the AGS. The weak plus electromagnetic production process: ν_μ + nucleus → W + μ + nuclear products, W → e + ν_e was studied in an aluminum spark chamber array. No events corresponding to the prompt muon and the decay electron were seen. On the basis of the calculated cross section and a measurement of the neutrino flux, it can be concluded that $m_W \geq (2.0 \pm 0.1)\ m_p$ assuming a 50% branching ratio into the leptons. The search was extended with a counter experiment designed to detect wide angle muons from the reaction sequence: p + tungsten → W + nuclear products, W → $\mu + \nu_\mu$. The use of a target with short interaction length supplemented by a steel shielding wall suppresses the contribution of muons from the decays of pions and kaons as well as the background of hadrons. The absence of wide angle muons in excess of those predicted from π and K decays permits the conclusion that if the W has mass between 2 and 6 BeV/c^2, the cross section for the above production reaction is less than $\sim 10^{-33}$ cm^2. (auth)

15665 MUON–PROTON ELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS. Ellsworth, R. W. (Univ. of Rochester, N. Y.); Melissinos, A. C.; Tinlot, J. H.; von Briesen, H. Jr.; Yamanouchi, T.; Lederman, L. M.; Tannenbaum, M. J.; Cool, R. L.; Maschke, A. Contracts AT(30-1)-875; AT(30-1)-1932. Phys. Rev., 165: 1449-65(Jan. 25, 1968). (UR–875–208).

The muon-proton elastic scattering cross section $d\sigma/dq^2$ was measured for momentum transfers in the range $10\ F^{-2} < q^2 < 31\ F^{-2}$ using a broad-spectrum muon beam of momenta between 1.5 and 6.0 BeV/c. The muons were incident upon a large hydrogen target surrounded by an array of spark chambers and scintillation counters. The results were compared with the equivalent electron-proton cross section to obtain a limit on the electromagnetic muon-electron difference. Assuming a lepton-vertex form factor of the type $f(q^2) = (1 + q^2/\Lambda^2)^{-1}$, and defining the muon-electron difference parameter D^2 by $1/D^2 = 1/\Lambda_\mu^2 - 1/\Lambda_e^2$, $D^2 \geq 107\ F^{-2}$ ($D^{-1} \leq 0.09$ F; D ≥ 2.04 BeV/c) was found for the 95% confidence limit. (auth)

15666 POSITRON MOMENTUM SPECTRUM AND BRANCHING RATIO OF $K_{\beta 3}^+$ DECAY. Eschstruth, P. T. (Princeton Univ., N. J.); Franklin, A. D.; Hughes, E. B.; Imlay, R. L.; Reading, D. H.; Bowen, D. R.; Mann, A. K. Phys. Rev., 165: 1487-90(Jan. 25, 1968).

The positron momentum spectrum and branching ratio of $K_{\beta 3}^+$ decay was remeasured in a spark chamber and counter experiment at the Princeton-Pennsylvania Accelerator. A branching ratio of (5.20 ± 0.19)% was obtained. The dominant coupling was found to be vector. Under the assumption of a real, constant form factor, with 90% confidence, admixtures greater than 4% tensor and 15% scalar coupling are excluded by the positron momentum spectrum of 4638 events; limits of 7% tensor and 5% scalar are set by 1393 previously reported events in which the π^0 was detected in addition to the positron. (auth)

15667 MEASUREMENT OF THE BRANCHING RATIOS OF $K_{\mu 2}^+$, $K_{\pi 2}^+$, K_{e3}^+, AND $K_{\mu 3}^+$. Dobbs, John MacGregor. Philadelphia, Univ. of Pennsylvania, 1967. 76p.

Thesis.

In an experiment performed at the accelerator with scintillation counters and spark chambers, the branching ratios for the K^+ decay modes $K_{\mu 2}^+$, $K_{\pi 2}^+$, K_{e3}^+ and $K_{\mu 3}^+$ were determined. For each event, the momentum and range of the charged secondary and the time interval between the arrival of the K^+ and its decay were measured. The momentum was measured in thin foil spark chambers placed in a magnetic field. The range was then measured in a thick-plate spark chamber in which all charged products from K^+ decay were stopped. K^+ decays-in-flight were eliminated through use of the timing information. The solid angle and detection efficiency of the apparatus were constant over the momentum interval 130 to 260 MeV/c. Based on approximately 23,000 measured events, the values for the branching ratios are (63.34 ± 0.44)% for $K_{\mu 2}^+$, (20.59 ± 0.40)% for $K_{\pi 2}^+$, (4.97 ± 0.16)% for K_{e3}^+ and (3.82 ± 0.29)% for $K_{\mu 3}^+$.

These values were determined by using for the τ and τ' branching ratios $(5.58 \pm 0.08)\%$ and $(1.70 \pm 0.055)\%$, respectively. A table of weighted averages of all K^+ branching ratio measurements is included. (Disser. Abstr.)

15668 MEASUREMENT OF THE PHASE OF THE CP VIOLATING AMPLITUDE FOR $K_1^0 \rightarrow \pi^+\pi^-$. Birnbaum, David. Rochester, N. Y., Univ. of Rochester, 1967. 97p.

Thesis.

The results of an experimental measurement of the phase of the CP violating amplitude in the decay $K_1^0 \rightarrow \pi^+\pi^-$ are presented. The experiment measured this phase directly by observing the interference between the anomalous decay and that of the residual K_1^0 component in a beam that was initially pure K^0. The kaons were produced in a tungsten target by an external proton beam. The K^0 contamination was kept to a negligible level by running at an energy of 2.4 GeV, below the threshold for K^0 production. There were 99 events observed in the region from 5.5 to 11 K_1 lifetimes. The estimated background contamination is 30 ± 10 events. From the time distributions of the observed events the phase angle is deduced as $70^{+\frac{19}{33}}$ degrees. (Disser. Abstr.)

15669 DECAY PROPERTIES OF THE Ξ HYPERON AND Ξ* RESONANCES. Merrill, Deane Whitney Jr. Berkeley, Calif., Univ. of California, 1967. 194p.

Thesis.

A sample of 2500 Ξ^- and 500 Ξ^0 hyperons, produced in ΞK, ΞKπ, and ΞKππ final states by K^- (in H_2) at incident momenta of 1.7 to 2.7 BeV/c, was analyzed. The data are from an exposure ("K-63") of 26 events/μb in the 72-inch bubble chamber; approximately 85% of the Ξ^- events and 60% of the Ξ^0 events were analyzed. For the Ξ, the spin and decay parameters α_Ξ and $\Phi_\Xi = \tan^{-1}(\beta_\Xi/\gamma_\Xi)$ are determined. Combining the data with 900 Ξ^- and 150^0 Ξ^0 events from an earlier experiment ("K-72"),* the following results are obtained: Ξ spin: $J = \frac{1}{2}$ favored over $J = \frac{3}{2}$ by ≈2.5 standard deviations; Ξ decay parameters (assuming $\alpha_\Lambda = 0.647 \pm 0.048$): $\alpha_{\Xi^-} = -0.398 \pm 0.041$, $\Phi_{\Xi^-} = 9.8^0 \pm 9.0^0$; $\alpha_{\Xi^0} = -0.413 \pm 0.104$. The Ξ* (1530 and Ξ* (1817) were observed; the data are insufficient for analysis of suggested Ξ* resonances at 1705 and 1933 MeV. The Ξ* (1530) electromagnetic mass difference $\Delta_m = m(\Xi^{*-}) - m(\Xi^{*0}) = 2.0 \pm 3.2$ MeV is measured. Using data partially reported it is found that for Ξ* (1530): $J \geq \frac{3}{2}$ favored over $J = \frac{1}{2}$ ($J = \frac{1}{2}$ hypothesis is ≈3.5% as probable as the $J = \frac{3}{2}$ hypothesis); $J^P = \frac{3}{2}^+$ favored over $\frac{3}{2}^-$ by ≈2.8 standard deviations. For Ξ* (1817), the hypotheses $J^P = \frac{1}{2}^+$, $\frac{1}{2}^-$, $\frac{3}{2}^-$, $\frac{5}{2}^+$, $\frac{7}{2}^-$, etc. (corresponding to l = 1, 2, 0 and 2, 1 and 3, 2 and 4, respectively) are favored over other hypotheses, but results are inconclusive due to large background. (Disser. Abstr.)

Strong (Baryon-Induced)

15670 (BNL–11993) THE STUDY OF 28.6 GeV/c p–p INTERACTIONS WITH 6 CHARGED PARTICLES IN THE FINAL STATES. Connolly, P. L.; Kenyon, I. R.; Morris, T. W.; Thorndike, A. M. (Brookhaven National Lab., Upton, N. Y.). Nov. 1967. 18p. (CONF-680103-5). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

Results from a study of high-multiplicity high-energy p + p interactions at 28.6 GeV/c in a hydrogen bubble chamber are described. The measurements of 29,500 pictures yielded 5230 well-reconstructed events. Mass distributions are shown from which the dominance of Δ (1236) is noted. Also considerable enhancement appears from 1440 to 1760 GeV which is not inconsistent with the known large decay rates of the N(1525) and N (1670). The 1-constraint fits show the presence of ω production in the reaction $p + p \rightarrow 2p + 2\pi^+ + 2\pi^- + \pi^0$. It is observed that the reaction $p + p \rightarrow 2p + 2\pi^+ + 2\pi^-$ shows several simple features which are consistent with dominance of the reaction by diffraction dissociation of the protons. But this dominance is not established by these features. (J.F.P.)

15671 (INR-P-816/VI/PH) SEARCH FOR EXCITED BARYONS IN PERIPHERAL NUCLEUS–NUCLEUS INTERACTIONS IN NUCLEAR EMULSION. Jurak, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 14p. Dep.

From a sample of peripheral nucleus – nucleus collisions a group of events was selected which can be regarded with a high degree of probability as a sub-sample of interactions of a pair of quasi-free nucleus, constituents of the colliding nuclei. An analysis of angular distributions of these has shown a significant difference between the interactions with small number of charged particles produced $/1 \leq n_m \leq 3/$ and these with a higher one $/4 \leq n_m \leq 12/$. The angular distributions of the former are not inconsistent with the assumption that meson production in these events occurs through intermediate isobar states with mass of about 2.5 GeV/c^2. (auth)

15672 ANALYSIS OF A NUMBER OF CHARACTERISTICS OF HIGH-ENERGY INTERACTIONS. Alibekov, M. I.; Eremenko, Yu. A.; Lukin, Yu. T.; Takibaev, Zh. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 85-9(Mar.-Apr. 1967). (In Russian).

On the basis of more than 100 showers recorded in photoemulsions Hasegawa concluded that special fireballs, H-quanta, which can be compared with nucleon–antinucleon pairs, are generated during high-energy interactions. The same methods are used to analyze a total of 25 nuclear interactions recorded on a unit consisting of a Wilson chamber, an ionization calorimeter and a system of hodoscopic counters. The average energy of the primary particles was 400 GeV and the average number of particles n_s was 8.5. The particles were separated into two groups with particles being scattered forward in one case and backward in the other case. The average number of tracks formed from one of two fireballs was 4.3 ± 2.3 (from 44 fireballs). The average mass of the fireball was close to three nucleon masses $M_f = 2.7 \pm 1.5$ GeV. The average Lorentz factor of the H-quantum was estimated at 2.0 ± 0.4. It is concluded that these characteristics of nucleon–nucleon interactions, which were determined from the angular distribution of secondary particles, on the average agree in the laboratory system of coordinates with the characteristics of showers having an asymmetry of $\alpha < 0.6$. (TTT)

15673 NEUTRAL STRANGE-PARTICLE PRODUCTION IN pp COLLISIONS AT 6.92 GeV/c. Alexander, G.; Shapira, A.; Simopoulou, E.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel). Nuovo Cim. (10), 53A: 455-64(Jan. 21, 1968).

Neutral strange particle production in pp collisions at 6.92 GeV/c was studied in the 80 in. HBC at BNL. Partial cross sections for the different channels are given. No evidence for hyperon-nucleon resonances was observed. Strong production of $N_3^*(1236)$ and $Y_1^*(1385)$ was seen in the four- and five-body final states, which was analyzed in terms of a one-pion-exchange mechanism. (auth)

15674 MEASUREMENT OF $p + p \rightarrow \pi^+ + d$ AT 90° AND 5 GeV/c. Ruddick, K. (Univ. of Minnesota, Minneapolis); Ratner, L. G.; Edwards, K. W.; Akerlof, C. W.; Hieber, R. H.; Krisch, A. D. Phys. Rev., 165: 1442-5(Jan. 25, 1968).

The differential cross section for the process $p + p \rightarrow \pi^+ + d$ was measured at 5.0 GeV/c for a center-of-mass angle of 90°. The experiment was done on the Argonne ZGS with the same apparatus as was used in a recent 90° proton-proton elastic scattering experiment. The extracted proton beam of the ZGS was made to impinge upon a CH_2 target. The pion and deuteron were detected by two spectrometers, each containing magnets and a scintillation-counter telescope, in coincidence. The incident beam flux was measured by a radiochemical analysis of the CH_2 target. The 90° cross section at 5.0 GeV/c was found to be 35 ± 9 nb/sr. (auth)

15675 PRODUCTION OF K MESONS IN THREE-BODY STATES IN PROTON–PROTON INTERACTIONS AT 6 GeV/c. Chinowsky, W. (Univ. of California, Berkeley); Kinsey, R. R.; Klein, S. L.; Mandelkern, M.; Schultz, J.; Martin, F.; Perl, M. L.; Tan, T. H. Contract W-7405-eng-48. Phys. Rev., 165: 1466-78(Jan. 25, 1968). (UCRL-17619).

Analysis of 9700 events, containing at least one observed neutral or charged decay, produced by 6-BeV/c protons in the LRL 72-in. liquid-hydrogen bubble chamber has yielded 1746 examples of the reaction proton + proton → hyperon + K meson + nucleon. Production cross sections for these three-body reactions are as follows: $\sigma(\Lambda K^+p) = 54^{+\frac{4}{5}}$ μb, $\sigma(\Sigma^0K^+p) = 17^{+\frac{4}{2}}$ μb, $\sigma(\Sigma^+K^0p) = 26 \pm 4$ μb, $\sigma(\Sigma^+K^+n) = 57 \pm 7$ μb. Strong N* production is observed in all channels. In particular, one or more $T = \frac{1}{2}$ resonant states with mass near 1700 MeV/c^2, decaying into ΛK^+, and a $T = \frac{3}{2}$ resonance with mass 1920 MeV/c^2, decaying into Σ^+K^+, are produced. In all cases the data are consistent with a production process dominated by a single-pion-exchange mechanism. No evidence is found for a dibaryon state in either the Λ-proton or Σ-nucleon system. (auth)

15676 MEASUREMENT OF RADIATIVE PROTON–DEUTERON INTERACTIONS AT 197 MEV. Koehler, Peter Friedrich Max. Rochester, N. Y., Univ. of Rochester, 1967. 170p.

Thesis.

Radiative p-d interactions were studied at 197 MeV by bombarding a target of liquid deuterium with a 90% polarized proton beam. A γ-detector gave the directions of photons of energy $E_\gamma \geq 40$ MeV; spark chambers triggered by large-area counters were used to determine the direction(s) and range(s) of the energetic charged particle(s) which emerged in coincidence with a γ-ray. Samples of events from three final states were extracted: (1) $p + d \rightarrow n_s + p + p + \gamma$; (2) $p + d \rightarrow p_s + d + \gamma$; (3) $p + d \rightarrow p + d + \gamma$. Events of type (1) exhibited angular distributions and a γ-spectrum in agreement with free ppγ results, while the cross sections were reduced by a factor of 0.46 ± 0.10. Differential cross sections for reaction (2)

were found to be reduced by a factor of 0.75 ± 0.15 from the values predicted for the free pick-up reaction; the γ-ray asymmetries were in good agreement with predictions from deuteron photodisintegration; the branching ratio for the production of the n-p system in the slightly unbound ^1S final state to that in the bound ^3S final state was found to be 0.22 ± 0.04. The cross section for reaction (3) was small and its study was strongly limited by the detection thresholds of the spark chambers. Events from the reaction p + d → p_s + n + p + γ could not be directly determined from the apparatus, but they were the only other contributors to the coincidence rates between a γ-ray and a single charged particle. By subtracting the measured contributions from reactions (1)–(3) from them, differential cross sections were obtained for quasifree n-p bremsstrahlung at three angles. Cross sections were deduced for free npγ from them and found σ^{npf} = (35 ± 12) μb. This result implies a ratio $\sigma^{npf}/\sigma^{ppf}$ = 50 ± 20. (Disser. Abstr.)

15677 EXPERIMENTAL STUDY OF ANTIPROTON–PROTON ANNIHILATION INTO AN ELECTRON–POSITRON PAIR AND ANTIPROTON–PROTON ANNIHILATION INTO TWO γ-RAYS FOR INCIDENT ANTIPROTON MOMENTA OF 1.50 GeV/c. Hartill, Donald LeRoy. Pasadena, Calif., California Inst. of Tech., 1967. 199p.

Thesis.

Upper limits for the differential cross sections at 90° in the center of mass system for the reaction $\bar{p} + p \rightarrow e^+ + e^-$ were measured for incident antiproton momenta of 1.50 and 2.50 GeV/c. These limits to the 90% confidence level were 1.8×10^{-34} cm²/st respectively. Two thin foil spark chambers were used to measure the laboratory angles of the electron and positron and two lead plate spark chambers were used to identify the electron and positron by their characteristic electromagnetic showers produced in such chambers. Assuming a one photon exchange mechanism for the annihilation, upper limits equal to 0.2 if $|G_E| = |G_M|$ for the electric and magnetic form factors of the proton for time-like momentum transfers of +5.1 $(GeV/c)^2$ and +6.8 $(GeV/c)^2$ were obtained from the cross section limits. The differential cross section at 90° in the center of mass sytem for the reaction $\bar{p} + p \rightarrow \gamma + \gamma$ was tentatively measured for an incident antiproton momentum of 1.50 GeV/c and an upper limit for this cross section was measured for an incident antiproton momentum of 2.50 GeV/c. The differential cross section at 1.50 GeV/c is based on two events giving $d\sigma/d\Omega|_{90°}$ $(\bar{p}p \rightarrow 2\gamma) = (1.6^{+1.1}_{-0.6}) \times 10^{-31}$ cm²/st. The upper limit to a 90% confidence level at 2.50 GeV/c is $d\sigma/d\Omega|_{90°}$ $(\bar{p}p \rightarrow 2\gamma) \leq 0.8 \times 10^{-31}$ cm²/st. Upper limits for the cross sections of the process $\bar{p} + p \rightarrow 3\pi^0$ for incident $\bar{p}$ momenta ranging from 1.00 to 2.50 GeV/c were measured. Differential cross sections for the process $\bar{p} + p \rightarrow 2\pi^0$ were tentatively measured for center of mass angles from 55° to 90° and for incident $\bar{p}$ momenta ranging from 1.00 to 2.50 GeV/c. The results for the $2\pi^0$ final state could, however, contain up to 50% background from the $3\pi^0$ final states. The relative rates between the $3\pi^0$ and the $\pi^+\pi^-\pi^0$ final states and between the $2\pi^0$ and the $\pi^+\pi^-$ final state appear to be at least a factor of two smaller than would be expected for a simple statistical model for the annihilation. (Disser. Abstr.)

Strong (Meson-Induced)

Refer also to abstract 15669.

15678 (JINR-P1-3640) ISSLEDOVANIE SVOISTV MEDLENNYKH π^+-MEZONOV, OBRAZOVANNYKH VO VZAIMODEISTVIYAKH π^--Xe PRI 9 GeV/c. (Investigation of the Properties of Slow π^+-Mesons Produced in π^--Xe Interactions at 9 GeV/c). Gadomskii, V.; Slovinskii, B.; Strugalskii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab of High Energy). 1967. 10p. (In Russian). Dep.

An investigation is made of multiplicity, angular distributions, and momentum characteristics of π^+-mesons with the momentum 50 MeV/c ≤ P_{π^+} ≤ 150 MeV/c produced in 9 GeV/c π^--Xe interactions. (auth)

15679 (JINR-P13-3653) ISSLEDOVANIE ZAKHVATA π^--MEZONOV VODORODOM V VODORODOSODERZHASHCHIKH VESHCHESTVAKH. (Investigation of π^--Meson Capture by Hydrogen in Hydrogenous Substances). Krumshtein, Z. V.; Petrukhin, V. I.; Ponomarev, L. I.; Prokoshkin, Yu. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 15p. (In Russian). Dep.

A probability of π^--meson capture by hydrogen in the Z_mH_n hydrides and compounds of $Z_kZ_lH_n$ type is investigated. The measurements were carried out by comparing of π^0-meson yields from the targets investigated and from the LiH target. It is shown that the model of "large mesic molecules" describes well the obtained results. Meanwhile the initial capture obeys the "Z-law"; a probability of π^- meson capture in Z_mH_n hydrides changes strongly from period (which determines Z atom) to period of the periodic table and depends also upon the type of chemical bond. (auth)

15680 (ORO-2504-117) MEASUREMENT OF K_2^0-p TOTAL CROSS SECTIONS AT LOW ENERGIES. Technical Report No. 748. Sayer, Gustav Andrew (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1967. Contract AT-(40-1)-2504. 107p. Dep. CFSTI.

Thesis.

The total cross sections of K_2^0's on protons are measured in the momentum range 168–343 MeV/c. The results are analyzed in terms of the zero-effective range theory of Dalitz and Tuan. An independent determination of the T = 1 $\bar{K}$–N scattering length is made. This is then compared with the scattering length of K^- – p experiments. (auth)

15681 (PPAD-630F) AN EXPERIMENTAL STUDY OF π^--NUCLEUS SCATTERING FROM 0.6 TO 1.6 GeV. Miller, Edward S. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Sept. 11, 1967. Contract AT(30-1)-2137. 137p. Dep. CFSTI.

Thesis. Submitted to Princeton Univ., N. J.

Meson (π^-)–nucleus absorption and diffraction cross sections were measured at a series of meson (π^-) energies from 600 to 1600 MeV for a dozen nuclei spanning a range in mass from Be to Au. These cross sections were analyzed in terms of an optical potential model of elastic scattering, yielding information on the magnitude of the real and imaginary parts of the potential and also a measure of the size of the interaction region. For the energy region covered, it was shown possible to relate directly the strength of the optical potential to the free two-body π N interactions. These calculations were refined to include second-order effects, the most important of which are multiple scattering corrections which involve nucleon–nucleon correlations within the nucleus. (J.F.P.)

15682 (UCRL-18041) RESONANCE PRODUCTION, PARTICULARLY Y_1^* (1385) AND ρ, IN $K^-p \rightarrow \Lambda\pi^+\pi^0\pi^-$ AND $K^-p \rightarrow \Lambda\pi^+\pi^-$; p_{K^-} = 2.1–2.7 GeV/c. Siegel, Daniel M. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 26, 1967. Contract W-7405-eng-48. 119p. Dep. CFSTI.

Thesis.

Some 20,000 $K^-p \rightarrow \Lambda\pi^+\pi^0\pi^-$ and 10,000 $K^-p \rightarrow \Lambda\pi^+\pi^-$ events are identified in the 72-inch hydrogen bubble chamber. Analysis of these reactions, by means of maximum likelihood fits to comprehensive models involving known resonances, yields cross sections and production angular distributions for quasi-two-body states $Y_1^*(1385)^\pm_0\rho^\mp_0$, $Y_1^*(1385)^0\pi^\mp$, and $\Lambda^0\rho^0$. Analysis of decay angular distributions for peripheral reactions indicates predominance of K meson exchange for $K^-p \rightarrow Y_1^*(1385)^+\rho^-$, and K^* exchange for $K^-p \rightarrow Y_1^*(1385)^+\pi^-$. (auth)

15683 A BUBBLE CHAMBER STUDY OF THE REACTIONS OCCURRING WITH STOPPING K^--MESONS IN A MIXTURE OF PROPANE AND FREON. Davis, H. (Univ. of Colorado, Boulder); Oppenheimer, F.; Knight, W. L.; Stannard, F. R.; Treutler, O. Nuovo Cim. (10), 53A: 313-26(Jan. 21, 1968).

Results are presented on the interactions of K^--mesons at rest in complex nuclei. The study is similar to those carried out in nuclear emulsion, with the important exception that the use of a bubble chamber permits the observation of Λ^0-hyperons and γ-rays from the decay of Σ^0-hyperons and π^0-mesons. This additional information allows one to resolve the difficulty encountered in the earlier work regarding the apparent requirement of a high probability for π^0 absorption in the parent nucleus. Such anomalous behavior of the π^0 is discounted. A general survey of star characteristics is given, and deductions made concerning the relative transition rates for the primary K^--capture processes. These are compared to data appropriate to other nuclei and various trends among the changing transition rates are noted. (auth)

15684 TWO-BODY PROCESSES IN K^-p INTERACTIONS AT 6 GeV/c. Colley, D. C. (Univ. of Birmingham, Eng.); Dodd, W. P.; Macdonald, F.; (and others). Nuovo Cim. (10), 53A: 522-37(Jan. 21, 1968).

Two-body processes in K^-p collisions at 6 GeV/c are discussed. Total and differential cross sections are given in all cases, and, where the number of events permits, estimations of density-matrix elements. (auth)

15685 OBSERVATION OF AN ENHANCEMENT IN THE I = 0 $\pi^+\pi^-$ SYSTEM AT 1085 MeV. Whitehead, C. (Atomic Energy Research Establishment, Harwell, Eng.); McEwen, J. G.; Ott, R. J.; Aitken, D. K.; Bennett, G.; Jennings, R. E. Nuovo Cim. (10), 53A: 817-22(Feb. 1, 1968).

Some results of an investigation of the $\pi^+\pi^-$ system produced in the reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ using 1.085-GeV mesons (π^-) are reported. Six sonic spark chambers were used to determine the momenta and trajectories of mesons (π^-) which entered a liquid hy-

drogen target. The mass spectra of the $\pi^+\pi^-$ system are shown, and resonance production is considered. (J.F.P.)

15686 COMPARATIVE ANALYSIS OF THE REACTION $\pi^-p \rightarrow \pi^+\pi^-n$ AT 8 AND 16 GeV/c. Bellini, G. (Faculte des Sciences, Orsay, France); Daugeras, B.; Fournier, D.; (and others). Nuovo Cim. (10), 53A: 798-803(Feb. 1, 1968).

The reaction $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ is examined using data from exposures of the heavy-liquid bubble chamber to beams of high-energy negative mesons (π). The results obtained at 15 and 16 GeV/c are compared to previous results at 8 GeV/c. Dalitz plots and invariant mass spectra are shown as well as differential cross sections for ρ^0 and f^0 production. At 16 GeV/c the reaction is dominated by two production channels which give rise respectively to low $\pi^+ + n$ masses and low $\pi^+\pi^-$ masses, the cross section for low $\pi^+ + n$ masses remains constant at 8 to 16 GeV/c, and the low-energy $\pi^+\pi^-$ masses are dominated by ρ^0 and f^0 at both 8 and 16 GeV/c. No significant shrinking of the forward diffraction peak is observed for these resonances. (J.F.P.)

15687 π^-p INTERACTIONS AT 720 MeV. Van de Walle, R. T.; Pols, C. L. A.; Schotanus, D. J.; Tiecke, H. J. G. M.; Toet, D. Z. (Univ. of Nijmegen, Netherlands). Nuovo Cim. (10), 53A: 745-61(Feb. 1, 1968).

The interactions of 720-MeV negative pions with protons were investigated using pictures from the 35-cm hydrogen bubble chamber. Partial cross sections were determined with the following results: σ(elastic) = (13.2 ± 0.5)mb, $\sigma(\pi^-p\pi^0)$ = (5.25 ± 0.30)mb, $\sigma(\pi^-\pi^+n)$ = (7.17 ± 0.35)mb, σ(neutrals) = (9.9 ± 0.7)mb, $\sigma(2\pi$ production) = (1.03 ± 0.13)mb. The elastic-scattering angular distribution was fitted with a fifth-order polynomial in cos θ^*_π which shows the effect of a significant $F_{\frac{5}{2}}$-$D_{\frac{5}{2}}$ interference contribution and predicts a value for $(d\sigma/d\Omega)(0°)$ in agreement with dispersion theory. For both single-π production channels, the two-body effective mass plots and cm angular distributions are presented, discussed and compared with the predictions from phase space, the Olsson-Yodh isobar model and the pole model of isobar production The $N^*(\frac{3}{2}, \frac{3}{2})$ isobar is seen to play an important role in the $\pi\pi N$ final states, but the agreement of the data with the existing isobar models and their assumptions is not satisfactory. A comparison of the different two-pion production cross sections $\pi^-p\pi^-\pi^+$, $\pi^-p\pi^0\pi^0$ and $\pi^-\pi^+n\pi^0$ suggests a strong contribution of $\pi^-p \rightarrow \eta^0n$ to the $\pi^-\pi^+n\pi^0$ final state. An upper limit for $\sigma(\pi^-p \rightarrow \eta^0n)$ of (3.0 ± 0.4) mb was obtained. (auth)

15688 FREQUENCY OF ^{6}He NUCLEI AMONG HAMMER TRACKS IN NUCLEAR EMULSION. Bhowmik, B.; Chand, T.; Chopra, D. V. (Univ. of Delhi). Nuovo Cim. (10), 53A: 400-6(Jan. 21, 1968).

Charges of hammer tracks produced by 1.5 GeV/c K^--interactions with emulsion nuclei were determined using the track-width measurement technique. It was found that nearly 13% of the hammer tracks are due to ^{6}He fragments. (auth)

15689 η AND η' PRODUCTION NEAR THRESHOLDS AND BACKWARD CHARGE-EXCHANGE DIFFERENTIAL CROSS SECTION IN π^--p REACTIONS. Hyman, E.; Lee, W.; Peoples, J.; Schiff, J.; Schultz, C.; Stein, S. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.). Contract AT(30-1)-1932. Phys. Rev., 165: 1437-41(Jan. 25, 1968).

An experiment was performed to study the reaction $\pi^- + p \rightarrow \eta + n$ near threshold, preliminary to a forthcoming measurement of charge asymmetry in η-meson decay. The η was identified by the velocity of the associated neutron. Neutrons were produced in the forward hemisphere in the center-of-mass system corresponding to the most energetic neutrons in the laboratory. Data were taken at π^- momenta between 670 and 805 MeV/c. The four neutron detectors made it possible to detect neutrons at angles of 0° to 21° from the incident pion beam. Backward differential cross sections are presented for both pion charge exchange and η production calculated from the data. A search was made for η' at pion momenta of 1.5 BeV/c and none was observed. $\sigma(\pi^-p \rightarrow n\eta') \leq 60$ μb was obtained. (auth)

15690 MULTIPION FINAL STATES FROM π^-p INTERACTIONS AT 3.2 AND 4.2 GeV/c. Chung, Suh Urk; Dahl, Orin I.; Kirz, Janos; Miller, Donald H. (Univ. of California, Berkeley). Phys. Rev., 165: 1491-1532(Jan. 25, 1968). (UCRL-16881).

An analysis was made of approximately 30,000 four-prong events at π^- beam momenta of 3.2 and 4.2 GeV/c, obtained with the 72-in. hydrogen bubble chamber at the Lawrence Radiation Laboratory. All the effective-mass distributions obtainable from the final states $p\pi^+\pi^-\pi^-$, $p\pi^+\pi^0\pi^-\pi^-$, and $n\pi^+\pi^+\pi^-\pi^-$, as well as the cross sections of the final states are presented. In addition, the results of the study of the quasi-three-body final states $N^{*++}(1238)\pi^-\pi^-$, $p\pi^-\rho^0$, $p\pi^-\omega$, and $p\pi^-\eta$ are presented. Particular emphasis is given to the production and decay of the A_1, A_2, and B enhancements; the A_1 and B enhancements observed in the data are consistent with the interpretations as kinematic enhancements, although the possibility exists that what was observed at our energies is an admixture of resonant states and kinematic enhancements. On the other hand, the A_2 enhancement can be interpreted only as a genuine resonant state. From the study of the decay angular correlations in the A_2 region as well as the control regions, it was determined that the lowest possible quantum numbers of the A_2 are $J^P = 2^+$. (auth)

15691 STUDY OF $\pi^-p \rightarrow \Sigma^-K^+$ AT 1170 MeV/c. Doyle, Joseph C.; Crawford, Frank S. Jr.; Anderson, Jared A. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 165: 1483-6(Jan. 25, 1968). (UCRL-17703).

The differential and total cross sections of the reaction $\pi^-p \rightarrow \Sigma^-K^+$ were measured for 1170-MeV/c pions incident on the Alvarez 72-in. hydrogen bubble chamber. Using 1338 events, the coefficients in the Legendre expansion of the differential cross section $d\sigma/d\Omega = A_0P_0 + A_1P_1 + A_2P_2$ were found to be A_0 = 18.38 ± 0.50 μb/sr, A_1 = 7.54 ± 0.96 μb/sr, and A_2 = 11.10 ± 1.21 μb/sr, corresponding to a total cross section σ = 231 ± 6 μb. No polynomials higher than P_2 are needed. The decay asymmetry $\alpha_{-}P_{-}$ of the decay $\Sigma^- \rightarrow n\pi^-$ is consistent with zero. Using previously reported results for the differential cross sections of the reactions $\pi^-p \rightarrow \Sigma^0K^0$ and $\pi^+p \rightarrow \Sigma^+K^+$ at 1170-MeV/c incident pion momentum, the results were compared with the predictions of the hypothesis of charge independence. No significant violations of that hypothesis were found. The measured polarization of the Σ^0 was compared with the prediction from the charge-independence hypothesis, using the measured differential cross sections of the three production reactions and the polarization of the Σ^+, as determined in the decay $\Sigma^+ \rightarrow p\pi^0$. The results agree with the prediction. (auth)

15692 OBSERVATION OF THE REACTION $K^- + {}^4He \rightarrow \Lambda^0 + \pi^- + p + d$. Kenyon, I. R. (Northwestern Univ., Evanston, Ill.); Sichirollo, A. E.; Sun, C. R.; Harth, E. M.; Zenone, S. Phys. Rev., 165: 1445-8(Jan. 25, 1968).

The observation of 164 definite and 20 ambiguous examples of the reaction $K^- + {}^4He \rightarrow \Lambda^0 + \pi^- + p + d$ produced by K^--meson absorptions at rest in the Northwestern University 20-cm liquid-helium bubble chamber is reported. It is confirmed that the reaction is dominated by the two-step process $K^- + {}^4He \rightarrow (\Sigma +$ nucleus) $+ \pi^- \rightarrow \Lambda^0 + p + d + \pi^-$. The momentum distributions of the baryonic particles (for events with π^--meson momentum below 180 MeV/c) are compared with the predictions of an impulse-model calculation. In this calculation the Σ-hyperon-nucleus interaction in the intermediate state is approximated by an effective potential acting on the Σ hyperon. It is found that very good fits are obtained with a potential of central depth around 37 MeV. This value implies that the Λ- and Σ-hyperon-nuclear potentials are of similar strengths. It is shown that such a result is consistent with the data on free $(\Sigma^\pm,p)$ and (Λ,p) interactions at low energies, and data on hypernuclear binding energies. This potential depth is also consistent with the meager information on the effective potential felt by Σ hyperons in medium-weight nuclei. There is therefore no evidence in the reaction observed for any final-state (Λ,p) resonance as postulated by Bugg, Bhatt, and Cohn. (auth)

Particle Interactions and Properties (Theoretical)

General

15693 (AED-C-23-20) HIGH ENERGY PHYSICS INDEX. Volume 5, Number 12(6141-6819). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1967. 254p. Dep.

A monthly report of material received at DESY is presented. This material covers experimental and theoretical high-energy physics and includes weak, electromagnetic, and strong interactions, strange particles, accelerators, methods and instruments, symmetry principles, and field theory. Author and report number indices are given as well as a subject index. (J.F.P.)

15694 (ITF-67-26) MODEL' VZAIMODEISTVIYA S PROIZVODNYMI. PROBLEMA UNITARNOSTI I NORMAL'NAYA FORMA RESHENIYA. (Interaction-with-Derivatives Model. The Unitarity Problem and Normal Form of Solution. Medvedev, B. V.; Polivanov, M. K.; Sukhanov, A. D.; (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 29p. (In Russian). (CONF-670544-6). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

An interaction-with-derivatives model, leading to the renormalization of field operators is considered. The Lagrangian T_w -

exponent is shown to be nonunitary in this model but this nonunitarity is of C-number type. Nevertheless the Heisenberg operators obtained earlier turn out to be hermitean. A current given, the unitary S-matrix is constructed, the latter being represented as normal exponent with nonhermitean index. The formulation of the unitarity condition for S-matrix of like form leads to a similarity with the optical theorem. (auth)

15695 (LYCEN-6734) EULER ANGLES FOR THREE AND FOUR IDENTICAL PARTICLE SYSTEMS. III. HELICITY FORMALISM. Laverriere, R.; Proriol, J. (Lyon Univ. (France). Institut de Physique Nucleaire). May 18, 1967. 6p. Dep.

A method to introduce permutation properties in the helicity eigenfunctions for three and four identical particle systems is presented. (auth)

15696 (NP-17252) ANNUAL REPORT, 1966-1967. (International Centre for Theoretical Physics, Trieste (Italy)). Nov. 1967. 58p. Dep.

A description is given of the activities of the International Centre for Theoretical Physics. The research carried out covers nuclear physics, field theory, the quark model, the N/D method, Regge pole theory, group theory, and superconvergence and current algebra. Other activities include training programs, the fostering of physics in developing countries, and a theoretical physicists forum. (J.F.P.)

15697 THE SYMMETRIC GROUP OF SOLUTIONS OF THE KLEIN-GORDON EQUATION IN AN EXTERNAL VECTOR FIELD. Grib, A. A. (Leningrad State Univ.). Differentsialnye Uravneniya, 2: 688-94(1966). (In Russian).

It is shown on the basis of the Klein-Gordon equation describing charged scalar particles in an external vector field that this equation allows the construction of not only a homogeneous Lorentz group, but also, depending on conditions on the vector field, a certain infinite Lie group, which replaces the subgroup of translations of the nonhomogeneous Lorenz group. Given the Lagrangian function of a charged scalar (pseudo-scalar) field interacting with an external vector field with density $L(x) = g^{\mu\nu}[\partial\bar{u}/\partial x^\mu][\partial u/\partial x^\nu] + m^2\bar{u}u + (g\bar{u}b^\mu[\partial u/\partial x^\mu] - g[\partial\bar{u}/\partial x^\mu]b^\mu u)$,

$$g^{\mu\nu} = \begin{pmatrix} -1000 \\ 0100 \\ 0010 \\ 0001 \end{pmatrix} (\mu, \nu = 0, 1, 2, 3), \quad (1)\ \partial_\mu b^\mu \neq 0,$$

where g is a constant and the fields are not quantized. The Euler equation for u(x) is derived: $\Box u - 2gb^\mu\partial_\mu u - g\partial_\mu b^\mu u - m^2 u = 0$. (2) and the admissible group of transformations is found for (2), the generator to be of form: $X = \xi^i(x)[\partial/\partial x^i] + \sigma(x)u[\partial/\partial u](i = 0, 1, 2, 3)$. A major conclusion of the study is the fact that the loss of translational invariantness with a certain change of translation generators is a consequence of a definite differential structure of the interaction. Lagrangian functions of the type used may occur in the theory of weak interactions. (ATD)

15698 RELATIONSHIP BETWEEN THE MASS SPECTRUM AND THE STRUCTURAL AND QUANTUM SYSTEMS OF ELEMENTARY PARTICLES. Akulov, N. S. (Dept. of Physics of Non-Destructive Inspection, Minsk). Dokl. Akad. Nauk BSSR, 11: 16-20(Jan. 1967). (In Russian).

The natures and interactions of elementary particles: muons, pions, and leptons, are studied. A "reon" is defined as a weightless particle found on the first quantum level. The "reon" and "anti-reon" are given the designations (+), (+), (0), and (0), the dot denoting strangeness. Several results are obtained: The masses of the muon and pion are obtained purely theoretically without the application of empirical constants; the structural formulas obtained indicate a complicated structure for elementary particles: leptons (muons, in particular) as well as pions are formed directly from neutrinos; heavier particles, from muons, pions, and their complexes; the relation obtained quantitatively describe the position of nearly all the basic lines and show significantly fewer "non-observable" lines in the mass spectra than the theories of Heisenberg, Nambu, and others; an analysis is made of the physical nature of strangeness; explanations of the relation between discontinuities in spin, isotopic spin, and particle mass; the transfer from an octet to a decouplet; the relation between isotopic spin and strangeness; and the formula for the mass of an octet are presented; from the formulas for the mass spectrum it follows that leptons are "parent matter." (JPRS)

15699 INVERSE PROBLEM FOR QUANTUM MECHANICS EQUATIONS WITH ENERGY-DEPENDENT POTENTIALS. Mal'chenko, V. I. Ukr. Mat. Zh., 18: 126-9(1966). (In Russian).

The inverse problem to that of finding the dispersion of elementary particles with energy-dependent potentials is studied: i.e., given the dispersion to find the potentials. A method is constructed which serves to reconstruct the potential in terms of the dispersion amplitude both in the approach of quantum mechanics and in that of quasi-optics. From the integral equation for the amplitude $f(s, \vec{\sigma})$, the following limiting equation is derived: $\lim_{\gamma\to\infty,\ \alpha<2\gamma} f(s, \vec{\sigma}, i\gamma) = -g/4\pi \int d\vec{x} c(s, \vec{x}) e^{-i\alpha x}$ and this relation allows the construction of a solution of the inverse problem of the Klein-Gordon equation $(\Delta + s - m^2)\ \varphi(\vec{x}) = gc(s, \vec{x})\ \varphi(\vec{x})$ under certain assumptions about the potential function $c(s, \vec{x})$. (ATD)

15700 POLARIZATION OF THE SPIN-ONE PARTICLES. Gabos, Z. Stud. Univ. Babes-Bolyai, Ser. Math.-Phys., 12: 87-91(1967). (In Rumanian).

The covariant matrix of polarization of the spin-one particles is considered assuming that for these particles the wave function can be made of spinorial wave functions. (auth)

15701 POSSIBLE METHOD FOR FINDING RESONANCES WITH INCOMPLETE KNOWLEDGE OF THE INTERACTION. Basina, A. N.; Volkova, O. I.; Kagasova, Ts. Ya.; Loktionov, A. A.; Mamontova, A. N.; Mikhailova, L. I.; Takibaev, Zh. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 9-17 (Mar.-Apr. 1967). (In Russian).

The generation of two particles in the first stage of a collision is a convenient concept in analyzing interactions at high energies. The excited particles can break into two, three, four, or more particles. The particles whose nature is not known are assumed to be pions, and their energy is determined from the momentum by a Monte Carlo method. The distributions of $\pi\pi$ and πp pairs from four-pronged interactions are given for the cases when one particle is known and the other is not and when both particles are unknown. The results are compared with data from hydrogen bubble chambers. If only identified particles are selected, the mass distribution becomes biased. Hence it is believed that this method gives the correct form for the spectrum of the effective masses of charged particle pairs, even though only $\sim 1/3$ of the tracks are identified. (TTT)

15702 DATA ON PARTICLES AND RESONANT STATES. Rosenfeld, Arthur H. (Univ. of California, Berkeley); Barash-Schmidt, Naomi; Barbaro-Galtieri, Angela; Price, Leroy R.; Soding, Paul; Wohl, Charles G.; Roos, Matts; Willis, William J. Rev. Mod. Phys., 40: 77-128(Jan. 1968).

Data on the properties of leptons, mesons, and baryons are listed, referenced, averaged, and summarized in tables and wallet cards. This is an updating of the Reviews of Modern Physics article of January 1967. (auth)

15703 UNITARY SPIN-ONE FOLDY-WOUTHUYSEN OPERATOR. Weaver, D. L. (Tufts Univ., Medford, Mass.). Nuovo Cim. (10), 53A: 665-70(Feb. 1, 1968).

A unitary operator is constructed for spin one, which transforms the Foldy-Wouthuysen Hamiltonian βE into the laboratory system Hamiltonian found by Weaver, Hammer and Good. Some properties of the operator are given including the behavior in the massless lemit. (auth)

15704 TRANSMISSION OF 4-DIMENSIONAL MOMENTUM IN INTERACTIONS AT 400 GeV. Eremenko, Yu. A.; Lukin, Yu. T.; Machekhin, A. M.; Takibaev, Zh. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 82-4(Mar.-Apr. 1967). (In Russian).

The interaction of cosmic rays with carbon was studied on a unit including a Wilson chamber, an ionization calorimeter and a system of hodoscopic counters. A total of 25 showers having an average energy of 400 GeV and an average multiplication of $n_s = 8.5 \pm 2.5$ were selected for analysis. The transmitted 4-dimensional momentum q, which is used to confirm the applicability of some model to the interaction, can be estimated from the momenta of the incident and target particles. If the showers are not too asymmetrical, the momenta of the secondary particles can be evaluated satisfactorily. Although the experimental data on q are insufficient to allow the applicability of a model to the process, it is clear that $\langle q \rangle$ significantly exceeds the mass of a pion. It is found that the number of particles n_s increases linearly with the momentum q. (TTT)

15705 COORDINATES OF THE MEAN POSITION FOR FREE PARTICLES. Gridneva, S. A.; Usik, P. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 54-6(Mar.-Apr. 1967). (In Russian).

It is proven that if a Hamiltonian description of a particle state is possible, there exists an operator for its average position, which is the even part of the operator of its coordinate. Concrete expressions for the operators of the mean position are found for Hamiltonian particles with spins of 0, 1/2, 1, and 3/2, and with a finite rest mass. For the photon which has no equation of state in

Hamiltonian form, there is no operator of the average position. It is concluded that the oscillations in the coordinates of free particles are associated with their internal motion which is responsible for the existence of the spin. (TTT)

15706 SCATTERING CROSS SECTIONS OF IDENTICAL POLARIZED FERMIONS WITH ANOMALOUS MAGNETIC MOMENTS. Shieh, S.-Y. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim. (10), 53A: 550-1(Jan. 21, 1968).

The result is reported of a calculation of scattering cross sections of two identical fermions with anomalous magnetic moment, taking into account the helicities of both incoming and outgoing particles. (L.B.S.)

15707 COVARIANT PROPAGATORS AND VERTEX FUNCTIONS FOR ANY SPIN. Scadron, Michael D. (Imperial Coll. of Science and Tech., London). Phys. Rev., 165: 1640-7(Jan. 25, 1968).

High-spin wave functions, propagator numerators, and vertex functions are developed in a covariant, on-shell manner. General formulas are given for massive bosons and fermions and for photons. The application to dispersion theory is discussed. (auth)

15708 SYMPOSIA ON THEORETICAL PHYSICS. VOLUME 4. LECTURES PRESENTED AT THE 1965 THIRD ANNIVERSARY SYMPOSIUM OF THE INSTITUTE OF MATHEMATICAL SCIENCES, MADRAS, INDIA. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967. 161p. (CONF-650123-Vol.4).

The conference included 15 papers. A separate abstract was prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 15709–15712, 15751, 15762, 15763, 15820, 15826, 15829, 15852–15854, 15930, and 16077.

15709 [ELEMENTARY PARTICLE PHYSICS]. Weisskopf, Victor (CERN, Geneva). pp 1-11 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

A broad view of current ideas in elementary particle physics is presented. Primary emphasis is given to the symmetry concept, and this is discussed historically. Beginning with the ideas of Newton and Rutherford the symmetry concept is developed, and the conclusions of various experiments on high-energy particle interactions are reviewed. (J.F.P.)

15710 GROUP REPRESENTATIONS FOR COMPLEX ANGULAR MOMENTUM. Venkatiesan, K. (Matscience, Madras). pp 91-101 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

The problem of the description of a state with a complex angular momentum is studied from the viewpoint of representations for the various groups where a spin description enters. The starting point is the little group of the Poincaré group associated with a timelike vector. (J.F.P.)

15711 AXIOMS AND MODELS. Stone, M. H. (Univ. of Chicago). pp 131-6 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

The usefulness of axioms and models in elementary particle physics theory is described. Beginning with earlier techniques based on the theory of linear spaces and their spectral resolution and synthesis the discussion includes the formulation of axioms and models in general. (J.F.P.)

15712 SEQUENT CORRELATIONS IN EVOLUTIONARY STOCHASTIC POINT PROCESSES. Srinivasan, S. K. (Indian Inst. of Tech., Madras). pp 143-54 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

A brief outline is given of developments in stochastic point processes. Phenomenological methods are used with emphasis on techniques and mode of application rather than on abstract theory. A stochastic process progressing with respect to a continuous parameter t characterizing the process is considered. It is assumed that the process involves another continuous parameter x with which a discrete random variable is associated. The parameter x may stand for the energy of a neutron, the age of a member of bacterial growth, or the energy of a cosmic ray particle. The discrete variable N(x,t) is considered a random variable the properties of which are connected with the information sought. Since a comprehensive probability frequency function governs the distribution of N(x,t), such processes are called point processes. (J.F.P.)

Electromagnetic

Refer also to abstracts 15748 and 15811.

15713 (DESY-67/43) ELECTROMAGNETIC INTERACTIONS. Joos, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1967. 41p. Dep.

A review of the theoretical aspects of electromagnetic interactions is presented. The topics covered are the general properties of the electromagnetic current operator, the meson (π) form factor, leptonic decays of vector mesons, photoproduction of vector mesons, multipion photoproduction, the photoproduction of mesons (π) at low and medium energies, and electromagnetic coupling constants and radiative decays. (J.F.P.)

15714 HIGH-ENERGY ASSUMPTION AND SUBTRACTION CONSTANTS IN COMPTON-SCATTERING SUM RULES. Wada, W. W. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 53A: 833-40(Feb. 21, 1968). (IC-67/37).

Under the assumption that in high-energy limit the forward Compton-scattering amplitude is given by the Born amplitude determined by the interaction of the photon field with the Dirac current of the proton, possible subtraction constants in the sum rules of the Compton scattering are discussed. (auth)

15715 PARTIALLY CONSERVED AXIAL-VECTOR CURRENT CONDITIONS ON STRANGE-PARTICLE PHOTOPRODUCTION AND ELECTROPRODUCTION AMPLITUDES. Ragusa, S. (Univ. of Chicago). Nuovo Cim. (10), 53A: 855-79(Feb. 21, 1968).

The photoproduction and electroproduction of strange particles on nucleons are studied in the framework of the algebra of currents and the partially conserved axial-vector current. Consistency conditions are derived for the non-Born amplitudes $\bar{A}_2^{(s,0)}(0)$, $\bar{A}_3^{(s,0)}(0)$ in the process $\gamma + N \to \Sigma + K$ and for the amplitudes $\bar{A}_1^{(s,v)}(0)$, $\bar{A}_4^{(s,v)}(0)$ in the reaction $\gamma + N \to \Lambda + K$. Evaluating these amplitudes using low-lying baryon resonant states the magnetic moments of the Λ, Σ^- and Σ^0 are calculated as well as the Dirac and axial-vector current mean square radii of the baryons. The Λ magnetic moment agrees with the available experimental value. The Dirac mean square radii are found to be in good agreement with the SU_3 predictions. The value derived for the β-decay axial-vector mean square radius is found to be consistent with the value obtained from pion electroproduction. (auth)

15716 ELECTROPRODUCTION OF ρ^0 MESONS. Blechschmidt, H. (Deutsches Elektronen-Synchrotron, Hamburg); Dowd, J. P.; Eisner, B.; Heinloth, K.; Karow, P.; Rathje, J.; Schmidt, D.; Smith, J. H.; Kanaris, A.; Wynroe, A. G. Nuovo Cim. (10), 53A: 1045-8(Feb. 21, 1968).

The differential cross section for the photoproduction of ρ^0 mesons is predicted from an analysis of experimental results for the $e + p \to e' + \rho^0 + p'$, $\rho^0 \to \pi + \pi$ interaction at 4.9 GeV. (L.B.S.)

15717 SINGLE-OPERATOR RELATION IN THE THEORY OF THE FREE ELECTRON. Gridneva, S. A.; Usik, P. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 51-3(Mar.-Apr. 1967). (In Russian).

The position operator of a Dirac operator is given as follows: $\bar{r} = r + (i\beta/2m)\bar{\alpha}$. On noting that $dr/dt = \bar{\alpha}$, the following relation can be found for the arbitrary operator of Dirac theory: $\bar{Q} = Q + (i\beta/2m)\, dQ/dt$. A strict derivation of this equation is carried out along with an explanation of the physical meaning of the $\bar{Q}$ operators. It is found that $\bar{Q}$ is the even part of the arbitrary operator in the case of a slow electron. A relativistic generalization of the above equation is also given. (TTT)

15718 STUDY OF RELATIVISTIC ROTATOR. Pavlova, O. S.; Khapaev, A. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 3, 55-9(May-June 1967). (In Russian).

The radiation from a relativistic rotator with oriented spin was studied using a quantum theory method. The data obtained were correlated with synchrotron radiation. Wave functions, spontaneous transitions, and approximations in matrix elements are calculated and linear components of radiation intensity are calculated without changing electron spin orientation. (R.V.J.)

15719 RHO-MESON COUPLING CONSTANTS AND E.M. FORM FACTOR OF THE PION. Selleri, F. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 53A: 657-64(Feb. 1, 1968).

The e.m. form factor of the meson(π) is calculated and it is shown that in the spacelike region and in the timelike region for

not-too-high energies it is essentially independent of the high-energy behavior of the T = J = 1 $\pi\pi$-phase-shift. With the previous result the ρ-meson coupling constant is evaluated at zero momentum transfer g_ρ and $g_\rho^2/4\pi = 2.2$ is obtained. This should be compared with $f_\rho^2/4\pi = 2.7$ as deduced from $\rho \to \pi\pi$ decay, f_ρ being the $\rho\pi\pi$-coupling constant on the mass-shell. Finally it is shown that the absence of the $\rho \to 4\pi$ decay implies that the ratio between complete and perturbative ρ-meson propagators equals unity at zero momentum transfer. (auth)

15720 COMPTON SCATTERING ON STABLE TARGETS OF ARBITRARY SPIN. Pais, A. (CERN, Geneva). Nuovo Cim. (10), 53A: 433-54(Jan. 21, 1968).

For Compton scattering on stable particles with spin S there exists, apart from the Thomson and the (g − 2) sum rules, a set of (2S − 1) total-cross-section sum rules (for $S \geq 1$) which, in unsubtracted form, are superconvergence relations. Applied to nuclei, the possible validity of this no-subtraction form can be related to asymptotic additivity. Low-energy theorems are proved to exist for all 2S + 1 intrinsic multipole moments. The case S = 1 is treated in some detail. (auth)

15721 ISOVECTOR FORM FACTOR AND THE ELECTROMAGNETIC NUCLEON-ISOBAR COUPLING CONSTANT. Bollini, C. G.; Giambiagi, J. J. (Fundacion Bariloche, Buenos Aires). Nuovo Cim. (10), 53A: 813-16(Feb. 1, 1968).

Fixed-t dispersion relations were previously used to evaluate photoproduction multipoles which were in excellent agreement with experiment. The same table is used for an alternative calculation of the isovector form factor also providing for the possibility of fixing the electromagnetic isobar –nucleon coupling constant with a method independent of the one used by Gourdin and Salin (Nuovo Cimento, 26: 193 (1963)). (J.F.P.)

15722 LAGRANGIAN OF QUANTUM ELECTRODYNAMICS. Maris, Th. A. J.; Dillenburg, D.; Jacob, G. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Nuovo Cim. (10), 53A: 823-7(Feb. 1, 1968).

A local Lagrangian for quantum electrodynamics, which results in the usual field equations but with a gauge-invariant current defined by a limiting procedure, is constructed. The purpose is to gain more insight into the boundary conditions governing the small-distance behavior of local field operators. These considerations outline a new approach and are incomplete. (J.F.P.)

15723 SOFT-PHOTON EMISSION AND SOME RADIATIVE DECAYS OF THE η AND χ^0 MESONS. Baracca, A. (Univ., Bologna); Bramon, A. Nuovo Cim. (10), 53A: 571-5(Jan. 21, 1968).

A current algebra calculation of the $\eta \to \pi^+\pi^-\gamma$ and $\eta \to \gamma\gamma$ decays is performed, taking into account the $\eta - \chi^0$ mixing. The same technique is used to evaluate the rates of $\chi^0 \to \gamma\gamma$ and $\chi^0 \to \pi^+\pi^-\gamma$ decays. (L.B.S.)

15724 RENORMALIZATION AND THE CLASSICAL ELECTROMAGNETIC ONE-BODY PROBLEM FOR AN EXTENDED BODY. Arnous, E. (CNRS, Orsay, France); Madore, J.; Papapetrou, A. Nuovo Cim. (10), 53A: 393-9(Jan. 21, 1968).

A decomposition of the Maxwell stress-energy tensor into two terms is proposed corresponding to the decomposition of the electromagnetic force into radiative and nonradiative parts given by Dirac. This permits the nonradiative force to be expressed as the divergence of a nonradiative tensor. This tensor is added to the matter tensor to form the total or renormalized matter tensor. (auth)

15725 NEW LOW-ENERGY THEOREMS FOR NUCLEON COMPTON SCATTERING. Singh, Virendra (Argonne National Lab., Ill. Rockefeller Univ., New York). Phys. Rev., 165: 1532-4(Jan. 25, 1968).

Two new low-energy theorems for Compton scattering from spin-½ targets, giving some terms of order ω^2, are derived using a recently obtained lemma. One of these theorems is a generalization to the spin-½ case of a similar theorem for the spin-0 case. The other theorem involves "magnetic moment radius," i.e., $[dG_M(t)/dt]_{t=0}$, which does not occur in any of the low-energy theorems obtained earlier. (auth)

15726 POLARIZED PHOTOPRODUCTION OF ω^0 MESONS. Krass, Allan S. (Univ. of California, Santa Barbara). Phys. Rev., 165: 1570-4(Jan. 25, 1968).

It is demonstrated in detail how linearly polarized photons can be used to determine the relative contributions of one-pion-exchange and diffraction production to the photoproduction of ω^0 mesons. Recent data are fitted by a superposition of the two processes, and predictions of polarization effects are given. (auth)

15727 LOW-ENERGY THEOREMS, DISPERSION RELATIONS, AND SUPERCONVERGENCE SUM RULES FOR COMPTON SCATTERING. Abarbanel, Henry D. I. (Princeton Univ., N. J.); Goldberger, Marvin L. Contract AF 49(638)-1545. Phys. Rev., 165: 1594-1609(Jan. 25, 1968).

A derivation of low-energy theorems for Compton scattering from spin-0 and spin-½ targets is given within the framework of dispersion theory. The physical helicity amplitudes and the zeros of these amplitudes forced by angular momentum conservation are used to write unsubtracted dispersion relations. The conventional requirement of gauge invariance is replaced by Lorentz invariance together with the knowledge that the photon is a massless spin-1 particle. From the dispersion relations a number of sum rules of the superconvergence type is extracted, one example of which reduces the Drell–Hearn result in the forward direction. (auth)

15728 CURRENT ALGEBRA AND THE $\eta \to \pi^+\pi^-\pi^0\gamma$ DECAY MODE. Intemann, Gerald W.; Lapidus, I. Richard (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 165: 1650-62(Jan. 25, 1968).

The rate for $\eta \to \pi^+\pi^-\pi^0\gamma$ was calculated in terms of the rate for $\eta \to \pi^0\gamma\gamma$, using current algebra and the hypothesis of a partially conserved axial-vector current. The results agree with a previous calculation by Singer based on a vector-meson dominance model. The rate for bremsstrahlung emission was found to be smaller than the direct decay rate, but not negligible. (auth)

15729 ASYMPTOTIC BEHAVIOR OF ELECTROMAGNETIC FORM FACTORS. O'Donovan, Patrick J. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 165: 1694-5(Jan. 25, 1968). (COO-264-399).

The asymptotic behavior of the electromagnetic form factors of the nucleon and of the M1 form factor for $N \to N^*$ (1238) + (virtual γ) is examined, using (1) superconvergent sum-rule techniques and (2) SU $(6)_W$ symmetry. The former yield conditions that are the same for the $NN^*\gamma$ form factor and the Pauli form factor $F_2(t)$, and that do not require the Dirac form factor $F_1(t)$ to fall off faster than $|t|^{-1}$. The $SU(6)_W$ symmetry leads to a differential cross section for N^* electroproduction exhibiting a faster asymptotic falloff (by a factor $|t|^{-2}$) than was obtained by previous authors. (auth)

15730 GAUGE FIELDS, SOURCES, AND ELECTROMAGNETIC MASSES. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Phys. Rev., 165: 1714-21(Jan. 25, 1968).

The hypothesis of strong-interaction gauge fields, with non-Abelian gauge invariance broken only by the 1^- particle mass terms, gives a natural source theory setting for the introduction of electromagnetic effects. The electromagnetic potential vector appears as a compensating field in the mass terms of the neutral 1^- particles. The resulting electromagnetic self-action is used to discuss mass displacements. The pion electromagnetic mass is computed in a number of ways—by direct calculation of various processes and by chiral methods, in two variants. The relationship of these approaches is established. A phenomenological modification of the chiral evaluation gives perfect agreement with the observed value. It is found, however, that the $(m_e/m_\mu)^2$ terms, which are neglected in this method, are not very small. Baryon electromagnetic mass splittings are described by a simple adaptation of gross mass-spectrum empirics. Agreement with the data is excellent. (auth)

15731 SELF-INTERACTION CORRECTIONS OF A CHARGE IN A NONRELATIVISTIC PARTICLE FORMALISM. Krizan, John E. (Univ. of Vermont, Burlington). Contract DA-31-124-ARO(D)-172. Phys. Rev., 165: 1725-9(Jan. 25, 1968).

A nonlinear equation for the description of self-interaction corrections is developed by means of stochastic mechanics. It is derived within a nonrelativistic framework in which fields do not appear. The linearized approximation of this equation is also examined, and an alternative, more conventional, interpretation of the resulting effective interaction is given. Calculations involving effects which have a possible interpretation as the Lamb shift and anomalous magnetic moment of the electron, and which are free of cutoffs, are made; these give semiquantitative agreement, offering some encouragement for a possible attempt at a relativistic generalization. (auth)

15732 PERTURBATIONS, DISPERSION RELATIONS, AND THE n-p MASS DIFFERENCE. Kayser, Boris (State Univ. of New York, Stony Brook). Contract 31-6016B. Phys. Rev., 165: 1760-9(Jan. 25, 1968).

Two questions concerning the reliability of dispersion-theoretic treatments of the effect of perturbing forces on binding energy are investigated. First, the change in binding energy caused by variation of the mass of the exchanged particle responsible for the binding is considered. It is shown that the surprising sign of the Dashen–Frautschi result for this change is not physically absurd.

Moreover, the methods used by Dashen and Frautschi generally give correct signs in potential-theory tests. Secondly, the special problems encountered in treating long-range or infinite-range (1/r) perturbations are dealt with in detail. It is emphasized that the basic Dashen–Frautschi mass-shift formula tends to yield incorrect signs when applied to a long-range perturbation, even when no infrared divergences are involved. A modified technique, which is proved to be accurate in both sign and magnitude in s-wave potential theory, even for 1/r forces, is used to make a fully relativistic calculation of the electromagnetic driving term for the n-p mass difference. In agreement with physical expectations, the driving term turns out to be a negative contribution to $M_n - M_p$, suggesting that the experimental sign must be ascribed to other effects. (auth)

15733 TEST FOR N*(1400) DOMINANCE OF NUCLEONIC FORM FACTORS. Lyth, D. H. (Univ. of Lancaster, Eng.). Phys. Rev., 165: 1786-8(Jan. 25, 1968).

By assuming that "nucleonic" form factors are dominated by the contribution of the N*(1400) resonance (which is the only object having the same quantum numbers as the nucleon), the relation $g_{\gamma NN}/g_{\gamma NN} = g_{\gamma NN^*}/g_{\gamma NN^*}$ is derived (the g's are coupling constants, and only magnetic coupling to the photon is considered). A recent phase-shift analysis of photoproduction off protons by Chau, Dombey and Moorhouse gives a value for $g_{\gamma NN^*}$ agreeing in sign but twice too large. (auth)

15734 EINFUEHRUNG IN DIE PHYSIK DER ROENTGEN- UND GAMMASTRAHLEN. UNTER BERUECKSICHTIGUNG DER ELEKTRONEN- UND NEUTRONENBEUGUNG. (Introduction to the Physics of X and Gamma Radiation. With Consideration of Electron and Neutron Diffraction). Regler, Fritz. Munich, Verlag Karl Thiemig KG, 1967. 404p. DM 64.-.

The fundamental concepts necessary to understanding and application of x and γ radiation in chemistry, biology, medicine, crystallography, mineralogy, metallography, and materials testing are discussed. The characteristic x-ray spectrum is described and its origin is discussed. The absorption of x radiation is described. The corpuscular-magnetic spectrum is briefly considered. The ionizing effect of x radiation and its photographic effect are described. The methods used for the dosimetry of x radiation are summarized. Polarization and penetration of x rays are discussed. The principles of x-ray spectroscopy are given, and the methods of x-ray spectroscopy are described. The physical principles for fine structure studies of crystalline materials are described. The diffraction of electron and neutron beams is briefly described. Examples are given of the use of x-radiation for crystal lattice diffraction. (J.S.R.)

15735 CALCULATION OF THE N*(1238) ELECTROMAGNETIC MASS DIFFERENCES BY S-MATRIX METHODS. Henyey, Frank Stephen. Pasadena, Calif., California Inst. of Tech., 1967. 48p.

Thesis.

The electromagnetic mass differences within the N*(1238) isomultiplet are calculated using the S-matrix theory of perturbations developed by Dashen and Frautschi. An ambiguity in the choice of methods for calculating the effect of one photon exchange, and lack of sufficient data on the rho meson lead to rather large uncertainties in the predicted mass differences. The results are consistent with experimental determinations of the differences, which also have rather large uncertainties. (Disser. Abstr.)

Weak

Refer also to abstract 15756.

15736 (ORO-2504-111) LORENTZ TRANSFORMATION OF PROBABILITY DENSITIES. Technical Report No. 731. Knop, Robert E. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sept. 1967. Contract AT(40-1)-2504. 21p. Dep. CFSTI.

The problem of the Lorentz transformation of a probability density to the laboratory frame from the center of momentum frame of a particle decaying isotropically into solid angle is reviewed. A FØRTRAN program which was written to perform such transformations together with averaging over another density such as the density of momentum of the decaying particle at production or the density of elapsed proper time since production is described. Selected transformations performed for decaying hyperons produced by stopped K^- in hydrogen are presented. (J.F.P.)

15737 (SRO-141) ANTINEUTRINO SPECTRUM FROM ^{235}U FISSION PRODUCTS. Avignone III, F. T.; Darden III, C. W. (South Carolina Univ., Columbia. Dept. of Physics and Astronomy). Dec. 1967. Contract AT(38-1)-474. 45p. Dep. CFSTI.

The energy spectrum of antineutrinos emitted by binary fission fragments of ^{235}U in secular equilibrium was calculated. The primary fission yields, used in this calculation, were calculated using the primary fission product charge distributions of A. C. Wahl. The yields are tabulated for 405 primary theoretically predicted fission products. The antineutrino spectrum derived was used to calculate the average cross section per antineutrino for the reactions $\bar{\nu}$ (p,n)e^+ and $\bar{\nu}$ (^{3}He,^{3}H)e^+. The cross sections are 1.09×10^{-43} cm^2/neutrino and 2.46×10^{-43} cm^2/neutrino respectively. The total number of antineutrinos per fission predicted with the calculated spectrum is 6.06. (auth)

15738 (SRO-142) ANTINEUTRINO FLUX GEOMETRY FACTORS FOR A SAVANNAH RIVER PRODUCTION REACTOR. Avignone III, F. T.; Darden III, C. W. (South Carolina Univ., Columbia. Dept. of Physics and Astronomy). Dec. 1967. Contract AT(38-1)-474. 32p. Dep. CFSTI.

The geometrical factors needed to calculate the flux of antineutrinos at a number of points near a Savannah River Production Reactor were computed and tabulated. Analytical expressions for both the vertical and radial dependence of the normalized power density functions were assumed. The geometrical factors are tabulated for nine different shapes of the normalized power density function by varying two parameters. (auth)

15739 MUON CAPTURE BY NUCLEI AND PROBLEMS OF WEAK INTERACTIONS. Balashov, V. V. (Moscow Univ.); Eramzhyan, R. A. At. Energy Rev., 5: 3-118(Nov. 1967).

A systematic summary of the problems of nuclear muon capture is given. The general ideas on which the effective Hamiltonian of the weak muon–muon interaction is based and also the main trends in experimental studies on muon capture are discussed. They analyze the reliability of various nuclear models and meson-capture mechanisms used in calculating the nuclear matrix elements. They consider the possibility of dispensing with nuclear models and adopting a phenomenological approach to muon-capture theory. Experimental projects are proposed. (auth)

15740 PHENOMENOLOGICAL ANALYSIS OF $K \to 3\pi$ DECAY. Gourdin, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 53A: 880-920(Feb. 21, 1968).

A phenomenological analysis is presented of the $K \to 3\pi$ decay assuming a discrete symmetry like TCP or time reversal and possible PC violations. Particular attention is paid to the $|\Delta I| = 1/2$ rule and a four parameter representation of the spectra corresponding to a second-order approximation of the amplitudes with respect to a convenient phase-space parameter is defined. (auth)

15741 STUDY OF LEPTONIC THREE-BODY DECAYS OF BARYONS. Nieto, Michael Martin (State Univ. of New York, Stony Brook). Rev. Mod. Phys., 40: 140-52(Jan. 1968).

Assuming isospin, the current-current form of the weak interactions of hadrons, and the most general matrix element for the hadron current, expressions are obtained for the decay rate, the final particle energy spectra, and the final baryon-lepton angular correlation. The results are presented in a manner that allows easier comparison between theories and significant data. In particular, a table is given which will allow comparisons between theory and experiment for decay widths. It also allows one to determine which of the many interactions are important in the energy spectra for the various decay modes. (auth)

15742 ATTENUATION EFFECTS ON THE POLARIZATION PROPERTIES OF RECOIL ELECTRONS IN $\bar{\nu}$ e-SCATTERING. Ivanov, Yu. P. Vestn. Mosk. Univ., Ser. III. Fiz. Aston., No. 3, 108-9(May–June 1967). (In Russian).

Polarization effects in $\bar{\nu}$ e scattering in the four-component theory of neutrinos were discussed previously, considering the longitudinal and transverse spin components of incident electrons. An attempt is made to evaluate the effect of attenuation on the polarization properties of recoil electrons in the presence of longitudinally polarized impinging electrons. (R.V.J.)

15743 UNITARITY AND RADIATIVE DECAY PROCESSES. Gaillard, M. K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 53A: 777-97(Feb. 1, 1968).

By means of the unitarity condition, the contribution of radiative $\pi\pi$ scattering to the matrix elements for radiative-decay processes such as $K \to 2\pi\gamma$ is studied. In particular, the final-state interaction phases associated with direct emission (as distinguished from bremsstrahlung) amplitudes in radiative decays depend on the importance of the corresponding direct emission amplitudes in radiative scattering. The cases of T-invariance and T-violation are

considered separately assuming CPT invariance throughout. In the limit of T-invariance it is found that the phase of a direct emission amplitude corresponding to a final-state di-pion system of angular momentum l is just the appropriate $\pi\pi$ scattering phase shift δ_l in the following cases. 1) The corresponding amplitude is forbidden in radiative scattering (e.g., magnetic emission for all l in spin-zero boson decays). 2) The nonradiative decay is forbidden (e.g., η-decay and K_S^2 decay). For K^+ decay the nonradiative decay is suppressed relative to direct emission by the $|\Delta I| = \frac{1}{2}$ rule; hence the approximation of a phase δ_1 for electric as well as magnetic amplitudes may be reasonable. For the case of T-violation, the partial-wave amplitudes $D_l(\overline{D}_l)$ for direct emission in radiative $K(\overline{K})$ decay into a final di-pion state of angular momentum l are related by $\overline{D}_l = \pm D_l^* \exp[2i\delta_l]$, if condition 1) or 2) above holds. Also the case in which these conditions do not hold is considered. It is found that CP-violating effects such as a difference in rates and spectra for radiative K^+ and K^- decays, or an interference between K_L and K_S amplitudes remain nonvanishing in the latter case. (auth)

15744 EXTENSION OF CABIBBO'S THEORY TO RADIATIVE LEPTONIC DECAYS OF PSEUDOSCALAR MESONS. De Baenst, P.; Pestieau, J. (Univ., Louvain, Belg.). Nuovo Cim. (10), 53A: 407-23(Jan. 21, 1968).

It is proposed to extend the Cabibbo theory to the radiative leptonic decays. As an application, the $\pi(K) \to l + \nu_l + \gamma$ decay is studied. The axial part is determined by using conservation of electromagnetic current and assuming A_1-dominance. For the vector part, assuming ρ-dominance, Vaks and Ioffe's relation for $\pi \to l + \nu_l + \gamma$ is extended showing that it is a good approximation for all physical values of the momentum transfer. Furthermore, it is shown that the relative phase between the vector and axial parts can be determined. The available experimental data on $\pi \to e + \nu_e + \gamma$ are compared with the predictions. (auth)

15745 CURRENT ALGEBRA AND NONLEPTONIC DECAYS. Li, Ming Chiang (Inst. for Advanced Study, Princeton, N. J.). Nuovo Cim. (10), 53A: 327-44(Jan. 21, 1968).

A new scheme is suggested. It is demonstrated that the s-wave (p.v.) and p-wave (p.c.) amplitudes in the nonleptonic hyperon decay can be well represented by the extrapolation of the amplitudes of associated productions $K_1 + Y \to \pi + N$ ($K_1 = K^0 - \overline{K}^0$) and $\varkappa_1 + Y \to \pi + N$. The model is also applied to other two-body decays. The results are good compared to the experimental data except for Λ_-^0 p-wave amplitude. (auth)

15746 RELATION BETWEEN VECTOR AND AXIAL-VECTOR CABIBBO ANGLES IN BROKEN SU_3 SYMMETRY. Nasrallah, N. F. (Univ. of Illinois, Urbana). Contract N00014-67-A-0305-0005. Nuovo Cim. (10), 53A: 387-92(Jan. 21, 1968).

The renormalization of the weak axial-vector coupling constant in the decay $\Xi^0 \to \Sigma^+ + e^- + \bar{\nu}$ is calculated on the basis of the assumption that the SU_3 breaking is unimportant at high energies and the result used to show that the equality of the vector and axial-vector Cabibbo angles, which is expected to hold in the limit of exact SU_3 symmetry, is preserved by the symmetry breaking. (auth)

15747 DIVERGENCE CONDITIONS FOR VECTOR AND AXIAL-VECTOR CURRENTS. Berman, S. M.; Frishman, Y. (Stanford Univ., Calif.). Contract AT(04-2)-515. Phys. Rev., 165: 1555-6(Jan. 25, 1968). (SLAC-PUB-326).

Equations for the divergence of the vector and axial-vector currents follow from the assumptions of Lorentz invariance, locality, the chiral $SU(3) \times SU(3)$ commutators between charges and the charge densities, and the usual electromagnetic and weak Hamiltonians. The divergence conditions lead to derivations of the low-energy meson theorems which do not involve Schwinger terms. (auth)

15748 AVOIDANCE OF KINEMATIC ZEROS IN PION-EMISSION CALCULATIONS. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 165: 1648-50(Jan. 25, 1968).

Some calculations of soft-pion emission based on current algebra appear to require model-dependent corrections owing to the presence of kinematic zeros of the amplitudes in question. It is shown how these zeros may be unambiguously avoided in cases of interest. (auth)

15749 CURRENT ALGEBRA, UNSUBTRACTED DISPERSION RELATIONS, AND RADIATIVE DECAYS OF STRANGE MESONS. Vaishya, J. S. (National Physical Lab., New Delhi. Univ. of Delhi); Gupta, K. C. Phys. Rev., 165: 1696-9(Jan. 25, 1968).

Analyzing the matrix elements related to the decays $K^+ \to l^+ + \nu + \gamma$ and $K^+ \to \pi^0 + l^+ + \nu + \gamma$ under the assumptions of (i) equal-time current commutation relations and (ii) unsubtracted dispersion relations, a Fubini-type sum rule is obtained between weak K-decay form factors, meson-meson couplings, and photon-meson couplings. Because of lack of knowledge about strange axial-vector meson (Q) couplings, the hypothesis of partially conserved axial-vector current (PCAC) is used to eliminate such couplings and thereby a sum rule is obtained between pseudoscalar meson-decay constants (F_K, F_π), K_{l3}-decay form factors (f_+), and VVP and VPγ couplings. The sum rule obtained is in excellent agreement with the experimental data. (auth)

15750 COMPTON SCATTERING FROM PROTONS AT 90° IN THE ENERGY RANGE OF 550 TO 1130 MeV. Kenton, Bernard. Los Angeles, Univ. of California, 1967. 79p.

Thesis.

The differential cross sections for the Compton scattering process, $\gamma + \rho \to \gamma' + \rho'$, were measured at the cms angle of 90° for incident photon energies from 550 to 1130 MeV. A bremsstrahlung beam was used. Both final state particles were detected. The time-of-flight and the laboratory angle of the recoil proton were used to determine the incident photon energy. The measured cross sections were consistent with, although somewhat greater than, the cross sections measured in previous experiments. (Disser. Abstr.)

Strong (General)

Refer also to abstract 15377.

15751 EQUIVALENT POTENTIAL APPROACH FOR STRONG INTERACTIONS. Balazs, L. A. P. (Tata Inst. of Fundamental Research, Bombay). pp 43-9 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

A generalization of the dispersion approach of Charap and Fubini, who constructed a potential by requiring that it reproduce the correct relativistic amplitude at the physical threshold is given. It is required that the potential reproduce the relativistic amplitude at any given energy. Two equal-mass particles are considered. (J.F.P.)

15752 HIGH ENERGY INELASTIC SCATTERING BY REARRANGEMENT OF SAKATONS. Imachi, Masahiro; Matsuoka, Tokeo; Ninomiya, Kansuke; Sawada, Shoji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 38: 1198-1200 (Nov. 1967).

High-energy two- and quasi-two-body scattering is examined on the basis of the sakaton triplet. Examples are given of allowed and forbidden processes caused by rearrangement of sakatons. Differential cross sections are illustrated schematically for several processes. (L.B.S.)

15753 CURRENTS AND HADRON DYNAMICS. Sharp, D. H. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 165: 1867-82(Jan. 25, 1968). (NYO-2171-230).

The investigation of the preceding paper is continued into the possibility that complete, dynamical theories can be formulated in terms of current densities and related operators. Here, these ideas are illustrated by showing how a model of self-interacting charged scalar mesons can be formulated in conformity with them. Because of the relative simplicity of this model as compared to other, more realistic, relativistic models, it is possible to take up in some detail topics like the irreducibility of the coordinates, the Heisenberg equations of motion for the current densities, the determination of the energy-momentum tensor by its equal-time commutation relations, and the use of functional representations of current algebras. It is also shown how electromagnetism can be incorporated into strong-interaction theories based on currents. The results of these two papers are reviewed and an attempt is made to abstract from them a tentative set of working hypotheses. (auth)

15754 MODEL OF SELF-INDUCED STRONG INTERACTIONS. Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., 165: 1535-46(Jan. 25, 1968).

It is postulated that the theory of self-induced strong interactions possesses an infinite-momentum limit. This limit is defined and its consequences are examined. It is found that some important simplifications occur if the limit exists. The limiting form of the theory is shown to have Galilean invariance with respect to motions transverse to the direction in which the momentum is infinite. (auth)

15755 HADRONIC CURRENTS. Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., 165: 1547-53(Jan. 25, 1968).

Questions concerning the hadronic currents are studied in the

context of the infinite-momentum limit of the theory of self-induced strong interactions. Representations for the matrix elements of currents are derived from the composite nature of the particles. The kinematic structure in the transverse plane is shown to be Galilean-invariant, and conclusions for the theory of the current algebra are drawn. (auth)

15756 SOME CONSEQUENCES OF THE SATURATION OF COVARIANT SUM RULES DERIVED FROM QUARK CHARGE-COMMUTATION RELATIONS. Patsakos, George (Stanford Univ., Calif.). Contract AF 49(638)-1389. Phys. Rev., 165: 1667-82(Jan. 25, 1968).

Some features of a model introduced recently by Fubini, Segrè, and Walecka and by Segrè and Walecka are examined. A high-energy contribution to a sum rule appearing in the model is calculated, producing better agreement with experiment. The results of the model are then applied to electromagnetic meson decays, the $N^* \rightarrow N\pi$ decay, and low-momentum-transfer N^* production by neutrinos. (auth)

15757 STRONG-COUPLING THEORY OF FERMION INTERACTIONS. Kikkawa, K. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 165: 1753-9(Jan. 25, 1968). (UR-875-209).

A strong-coupling approach to the fermion interactions is proposed. This is useful in the determination of the mass of the bound state when the kinetic energy of the constituents is smaller than their rest mass. The quark model is studied by this method. In the strong-coupling limit, the following statement is proved: assuming (i) Lorentz-invariant and local (nonderivative) interactions, (ii) SU(3) invariance, and (iii) quark and antiquark number conservations in the limit when the quarks are at rest, (a) the system does not have, in general, any higher invariance than SU(3), (b) nevertheless, every localized eigenstate of the Hamiltonian belongs to the irreducible representation of the nonchiral $U^{(+)}(6) \times U^{(-)}(6)$. Furthermore, if (iv) one restricts oneself to the four-fermion interactions, then (c) the system is exactly solvable, and the mass formula is given by $M = m_0 N_Q + a(N_Q - 6)^2 + b[G^2(3) - 4G^{(+)}(3) \cdot G^{(-)}(3)] + c[G^2(6) + 2S^2 + 6B^2]$, where m_0, a, b, and c are arbitrary real constants, and N_Q, B, $G^{(\pm)}(6)$ $[G(6) = G^{(+)}(6) + G^{(-)}(6)]$, $G^{(\pm)}(3)$ $[G(3) = G^{(+)}(3) + G^{(-)}(3)]$, and S are the quark and antiquark number, the baryon number, the generators of $SU^{(+)}(6) \times SU^{(-)}(6)$, those of $SU^{(+)}(3) \times SU^{(-)}(3)$, and the spin operator, respectively. It is also shown that only a restricted class of irreducible representations is realized in the quark system. The three-body forces among quarks and the three-triplet model proposed by Han and Nambu are briefly discussed. (auth)

15758 STRONG-INTERACTION SUM RULES FOR PION–HADRON SCATTERING. Gilman, Frederick J.; Harari, Haim (Stanford Univ., Calif.). Contract AT(04-3)-515. Phys. Rev., 165: 1803-29(Jan. 25, 1968). (SLAC-PUB-345).

Using Regge high-energy behavior, the chiral algebra of charges, and pion pole dominance of the divergence of the axial-vector current, all the strong-interaction sum rules which hold for elastic pion-hadron scattering amplitudes at $t = 0$ are derived. These include charge-algebra sum rules as well as superconvergence relations. The distinction is made between "pure" $t = 0$ sum rules (class I) and "extrapolated" sum rules (class II), relating them to the evenness or oddness of the helicity flip in the t channel. Using the explicit crossing relations for the relevant helicity amplitudes, the connection of class-I superconvergence relations to the charge-algebra sum rules is established, and the algebraic structure of class-I sum rules is then discussed in terms of representations of the $SU(2) \times SU(2)$ chiral algebra of charges, for particle states moving with infinite momentum. The properties of the mass operator in $SU(2) \times SU(2)$ are analyzed, and it is shown that even in the presence of $SU(2) \times SU(2)$ symmetry breaking the $(\text{mass})^2$ values of all the (mixed) eigenstates of an irreducible representation of the algebra are predicted to be equal. Since these eigenstates can be determined from the matrix elements of the vector and axial-vector charges, a large number of nontrivial mass relations are obtained. Class-II superconvergence relations, sum rules for $t \neq 0$, and sum rules for the derivative with respect to t of the scattering amplitude at $t = 0$ are briefly discussed. Many applications of the strong-interaction sum rules are presented, including a model consisting of $I = 0$ and $I = 1$ scalar, pseudoscalar, vector, and axial-vector mesons. The predictions of the model, as well as those of the other sum rules, are derived and are found to be in satisfactory agreement with experiment. (auth)

15759 CURRENTS AS COORDINATES FOR HADRONS. Dashen, R. F. (Inst. for Advanced Study, Princeton, N. J.); Sharp, D. H. Contract AT(30-1)-2171. Phys. Rev., 165: 1857-66(Jan. 25, 1968). (NYO-2171-231).

The possibility that complete, dynamical theories can be formulated in terms of current densities and similar operators is investigated. Our approach to this problem is through the study of models like nonrelativistic quantum mechanics or the quark model. Generalizing what one learns from these models, it is evident that such a program is, in principle, feasible. Whether or not such a program will prove useful remains an open question. No attempt is made to maintain mathematical rigor. Rather, an attempt is made to isolate the physics upon which a formulation of hadron dynamics in terms of currents would be based. (auth)

Strong (Baryon No. = 0)

15760 (LYCEN–6751) THEORETICAL STUDY OF PION ANGULAR DISTRIBUTIONS IN PROTON–ANTIPROTON ANNIHILATIONS UP TO FOUR PIONS. 2. BY A SIMPLE MODEL. Laverriere, R.; Proriol, J. (Lyon Univ. (France). Institut de Physique Nucleaire). July 10, 1967. 52p. Dep.

To study the pion angular distribution in proton–antiproton annihilations, a simple model starting from the model of Koba and Takeda is presented: the nucleons are assumed to be formed by a core and a pion cloud and final pions can be produced by core annihilation and cloud emission. A detailed kinematical study of all the possible annihilation reactions is made with very simplified assumptions for the physical processes. Resonance production is considered. Numerical calculations are made for 1.61-, 3.25-, and 5.70-GeV incident laboratory antiproton momenta. When a comparison with the experimental data is possible, very good agreement is found for the angular distributions and asymmetry coefficients. (auth)

15761 (LYCEN–6757) THEORETICAL STUDY OF PION ANGULAR DISTRIBUTIONS IN PROTON–ANTIPROTON ANNIHILATIONS UP TO FOUR PIONS. 1. BY THE CONVENTIONAL LAGRANGIAN FIELD THEORY. Laverriere, R.; Proriol, J. (Lyon Univ. (France). Institut de Physique Nucleaire). July 10, 1967. 36p. Dep.

An extensive study of proton–antiproton annihilations into mesons is made by consideration of Feynman graphs. The aim is to derive all possible information in that scheme mainly about angular distributions. Numerical applications are made for 1.61-, 3.25-, and 5.70-GeV/c incident laboratory antiproton momenta. The conclusions are that there is a qualitative agreement concerning the angular distributions but often serious failures concerning the cross sections. These conclusions emphasize the legitimacy of building phenomenological models to study such elementary particle processes. Such a model is presented. (auth)

15762 "REPULSIVE" POTENTIAL APPROACH TO PION RESONANCES. Mitra, A. N. (Univ. of Delhi). pp 51-8 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

A phenomenological approach to meson (π) interactions is considered in order to understand some of the meson (π) resonances. S-wave and p-wave interactions are considered, and some physical consequences of the assumption that the $\pi-\pi$ force has a long-range repulsion and a short-range attraction are discussed. (J.F.P.)

15763 RENORMALIZABILITY OF HIGHER SPIN THEORIES. Lukierski, J. (Univ. of Wroclaw). pp 69-89 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

A modification of higher spin particle theory, which leads to much less stringent conditions for the renormalizability, is presented. The projection operator on the definite spin subspace, the conditional and unconditional projection operator for field equations, noncovariant and covariant propagator theory, the renormalizability problem, and the extended Steuckelberg formalism for neutral vector meson theory are covered. (J.F.P.)

15764 THE BEHAVIOR OF THE $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ S-WAVE BELOW THRESHOLD. Common, A. K. (Univ. of Kent, Canterbury, Eng.). Nuovo Cim. (10), 53A: 944-5(Feb. 21, 1968).

The properties of the $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ S-wave amplitude in the interval $0 \leq s \leq 4$ are investigated using crossing symmetry and positivity properties due to unitarity. It is shown that the above-mentioned amplitude has a unique minimum in this region and that it is located between $s = 1.29$ and $s = 1.7$. (auth)

15765 COMPARISON OF THE ANNIHILATION OF ANTIPROTONS AT REST IN HYDROGEN AND DEUTERIUM. Bizzarri, R. (Univ., Rome. Instituto Nazionale di Fisica Nucleare, Rome). Nuovo Cim. (10), 53A: 958-68(Feb. 21, 1968).

It seems reasonable to assume that the annihilation of antiprotons at rest in liquid hydrogen and deuterium occurs from an atomic initial state of definite spin. The consequences of this fact on the possibility of comparing annihilation frequencies in hydrogen and deuterium are discussed. From the existing experimental data an estimate is obtained of the relative annihilation rates in the different spin and charge states of the antiproton-nucleon system. (auth)

15766 FORMULATIONS OF THE ρ BOOTSTRAP. Lyth, D. H. (Univ. of Lancaster, Eng.). Nuovo Cim. (10), 53A: 969-1006(Feb. 21, 1968).

Starting from N/D equations proved for the exact I = J = 1 $\pi\pi$-scattering amplitude, a no-cut-off formulation of the ρ bootstrap is deduced which is seen to correspond to a certain procedure suggested by Atkinson and Contogouris. The introduction of a cut-off parameter is also studied; it is found that for very small values of the $\rho\pi\pi$ coupling constant the large-cut-off limit exists and corresponds to the present formulation, but that for physical values of the coupling constant no limit exists. Results are for the most part stated and proved rigorously, using the techniques of functional analysis in Hilbert space. Much weaker conditions are given than have hitherto been published for (i) existence of an N/D decomposition, (ii) uniqueness of the solution of the integral equation for N, (iii) the boundedness and continuity behavior of principal-value integrals extending to infinity. (auth)

15767 CURRENT ALGEBRA AND $\pi-\pi$ SCATTERING LENGTHS. A DISPERSION RELATION APPROACH. Donnachie, A. (CERN, Geneva). Nuovo Cim. (10), 53A: 933-44(Feb. 21, 1968).

The usual simple linear expansion of the scattering amplitude in s, t and u is used to continue on to the mass shell but not to physical values of s. The continuation to physical s values is made using a linear combination of the partial-wave dispersion relations on the first and second Riemann sheets, into which any desired effects of the unitarity cut may easily be inserted. A complicated spectrum of T = 0 and T = 2 scattering lengths is obtained. Many of the qualitative features of the solution are in agreement with other calculations in which some account has been taken of the unitarity cut. (auth)

15768 SPECTRAL-FUNCTION SUM RULES AND MASSLESS MESONS. Capra, F. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim. (10), 53A: 1056-8(Feb. 21, 1968).

It is pointed out that Weinberg's second sum rule for the spectral functions of vector and axial-vector current propagators and its generalization to SU(3) × SU(3) can be obtained in a consistent way using the asymptotic symmetry approach only if the relevant mesons are massless. (L.B.S.)

15769 T = 0 AND T = 2 $\pi-\pi$ SCATTERING LENGTHS. Minguzzi, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 53A: 1053-5(Feb. 21, 1968).

A theoretical argument based on time-reversal invariance is presented, which predicts a repulsive interaction in the isotopic-spin T = 2 with $a_2 \sim -0.3$ pion Compton wavelengths if a strong interaction is assumed in the T = 0 state. (L.B.S.)

15770 ACCURATE SOLUTION OF BETHE-SALPETER EQUATIONS FOR TIGHTLY BOUND FERMION-ANTIFERMION SYSTEMS. Narayanaswamy, P.; Pagnamenta, A. (CERN, Geneva). Nuovo Cim. (10), 53A: 635-56(Feb. 1, 1968).

The Bethe-Salpeter equation for a fermion-antifermion system for the dynamical generation of a bound state via the exchange of a pseudoscalar particle leads to a set of four coupled integral equations for the state $J^P = 0^-$ and a system of eight for 1^-. It is argued that physically sensible solutions exist only after the introduction of a cut-off. These equations are solved with high accuracy by expanding the invariant amplitudes in terms of hyperspherical harmonics and then retaining the lowest n contribution only. It is found that for weakly bound systems the 1^- state is always lighter than the 0^- while for strong couplings the situation is reversed. Considering this solution as a relativistic quark model to form mesons as quark-antiquark bound states, the ratio 4:1 between the masses of the vector and the pseudoscalar mesons occurs for quark masses of about two nucleon masses. For the case of scalar particles one obtains an algebraic perturbation formula which is very accurate in the limit of small exchange masses. (auth)

15771 THE GENERAL SCATTERING PROCESS PV → VV AND SUPERCONVERGENCE. Kellett, B. H. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 53A: 625-34 (Feb. 1, 1968).

The general scattering process PV → VV is analyzed in detail and nine superconvergent sum rules are found. These are saturated with 0^- and 1^- particles for the various possible reactions and the results are compared with the predictions of $U_{6,6}$. It is found that one of the sum rules gives, in every case, either the $U_{6,6}$ result or is identically satisfied. (auth)

15772 Kπ RESONANCES. Cho, K. S.; Liou, M. K. (Univ. of Manitoba, Winnipeg). Nuovo Cim. (10), 53A: 544-6(Jan. 21, 1968).

The question of whether a mutual supporting mechanism in the framework of the reciprocal bootstrap exists for the κ-meson and K^* is investigated. Some qualitative features of the problem are discussed, considering the threshold values of $N_l(s)$ in the N/D representation of the l-th partial wave amplitude for K^*, κ, and for ρ exchange. (L.B.S.)

15773 MESON DECAYS IN BROKEN SU_3. Gounaris, G. J. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cim. (10), 53A: 557-70(Jan. 21, 1968). (COO-264-413).

It is shown that, in the framework of the vector-meson dominance model, SU(3) violations can be taken into account by using superconvergence relations and the generalized first sum rule of Weinberg. The decay rates of $\pi^0 \to 2\gamma$, $\omega \to \pi^0\gamma$, and $\rho \to \pi\gamma$ are then calculated, and a relation is derived between $\Gamma(\eta \to 2\gamma)$ and the branching ratio $\Gamma(\eta \to \pi^+\pi^-\gamma)/\Gamma(\eta \to 2\gamma)$. (L.B.S.)

15774 CAN CURRENT ALGEBRA DETERMINE THE LOW-ENERGY $\pi-\pi$ SCATTERING AMPLITUDE? Iliopoulos, J. (CERN, Geneva). Nuovo Cim. (10), 53A: 550-6(Jan. 21, 1968).

It is shown that current algebra, combined with unitarity and crossing, uniquely determines the $\pi-\pi$ scattering amplitude at low energies. The values obtained in this way for the s-wave scattering lengths are in agreement with those predicted by Weinberg. (L.B.S.)

15775 VECTOR AND SPINOR CURRENT ALGEBRA AND THE N/D METHOD. Drummond, I. T. (Cambridge Univ., Eng.). Nuovo Cim. (10), 53A: 577-91(Feb. 1, 1968).

An N/D model of weak amplitudes analogous to the ladder approximation of Bronzan, Gerstein, Lee and Low is discussed. It is applied to the case of vector-vector current commutators and spinor-spinor anticommutators. The model does not of course yield the detailed assumptions of current algebra but is consistent with them. It shows how these assumptions are compatible with the analyticity properties usually assumed for invariant amplitudes. By means of the model it is possible to indicate the problems involved if a bootstrap calculation is to yield the results of current algebra. (auth)

15776 MODIFIED BORN AMPLITUDES FOR THE VECTOR MESON SYSTEM. Brown, D. J. (Carleton Univ., Ottawa). Nuovo Cim. (10), 53A: 376-86(Jan. 21, 1968).

The amplitudes for vector-meson scattering arising from the exchange of one vector meson are calculated. These Born amplitudes are then modified by the introduction of a quadrilinear term in the Lagrangian which is derived from an SU_3 gage invariant theory. It is shown that this point interaction has a large effect on the 1^+ amplitudes. (auth)

15777 PION-PION SCATTERING, CURRENT ALGEBRA, UNITARITY, AND THE WIDTH OF THE RHO MESON. Brown, Lowell S.; Goble, Robert L. (Yale Univ., New Haven). Phys. Rev. Lett., 20: 346-9(Feb. 12, 1968).

It is shown that the current-algebra result for the pion-pion scattering amplitude in the low-energy limit may be extended through a useful range of physical energies by making use of the condition of elastic unitarity. S-wave phase shifts are predicted that vary roughly linearly with energy up to the region of the K-meson mass, at which the isospin-0 phase shift is +19° while the isospin-2 phase is −12°. The isospin-1, P-wave scattering length as determined by the low-energy current-algebra result, coupled with the knowledge of the mass of the ρ meson, gives a value for the width of the ρ decay into two pions that agree well with experiment. (L.B.S.)

15778 CROSSING-SYMMETRIC BOOTSTRAP AND EXPONENTIALLY FALLING FORM FACTORS. Harte, John (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 165: 1557-64(Jan. 25, 1968). (UCRL-17735).

It is shown that form factors with the asymptotic behavior $F(t) \sim \exp(-|t|^{\frac{1}{2}})$ are a consequence of the nonlinear bound-state equation for the wave function in the crossing-symmetric bootstrap model. This nonlinear equation incorporates the notion that the constituent particles are themselves composite. The result is obtained both from the Schrödinger equation and the Bethe-Salpeter equation; in the latter case, it is argued that the result should be valid for a wide class of interaction kernels. (auth)

15779 REGGE-POLE MODEL FOR πp, pp, AND $\bar{p}p$ SCATTERING. Rarita, William (Univ. of California, Berkeley); Riddell, Robert J. Jr.; Chiu, Charles B.; Phillips, Roger J. N. Contract W-7405-eng-48. Phys. Rev., 165: 1615-39(Jan. 25, 1968). (UCRL-17523).

A model for high-energy πp, pp, and $\bar{p}p$ elastic scattering at small momentum transfer is presented, based on the assumed dominance of a few Regge poles in the crossed channel. For πp scattering these are the P, P′, and ρ poles; for pp and $\bar{p}p$, ignoring isospin dependence, they are P, P′, and ω. This model fits a wide variety of data, including the differential cross sections that shrink for pp but not for πp or $\bar{p}p$, recent results from Brookhaver on total cross sections and ratios of the real to imaginary parts of the forward scattering amplitude, and also recent πp and pp polarization results, but it gives zero polarization for πp charge-exchange scattering. (Although the latter disagrees with experiment, additions to the model to correct this insufficiency would affect the other results but little.) The factorization property of Regge poles is tested by these fits to data for the P and P′ couplings. (auth)

15780 PHENOMENOLOGICAL REGGE TRAJECTORY OF THE ρ MESON. Aaron, Ronald; Vaughn, Michael T. (Northeastern Univ., Boston). Phys. Rev., 165: 1722-4(Jan. 25, 1968).

A phenomenological model of the Regge trajectory of the ρ meson, based on a dispersion relation for the trajectory function and a parametrized absorptive part, is constructed and compared with existing data for $t \leq 0$, and with possibly observed recurrences. A linear term, which may or may not be entirely due to inelastic channels, is required to explain the data. (auth)

15781 CALCULATION OF THE LOW-ENERGY S-WAVE PION–PION INTERACTION FROM THE K_{e4} DECAY USING CHARGE COMMUTATION RELATIONS. Matsuda, S.; Oneda, S. (Univ. of Maryland, College Park). Phys. Rev., 165: 1749-52 (Jan. 25, 1968).

By making use of an appropriate charge commutation relation the low-energy pion-pion scattering length was computed directly from the rate of K_{e4}-decay. The main differences from previous approaches are as follows: (a) Instead of using the current commutation relations (which have been extensively used with the soft-pion technique), the better-known charge commutation relations are used. This as in the Adler–Weisberger calculation, avoids taking the usual soft-pion limit $k_\mu \to 0$; instead only $k^2(=-m_\pi^2) \to 0$, which is certainly a smaller extrapolation. (b) In contrast with previous calculations of K_{e4} decays, which utilized essentially the kaonic PCAC ($m_K \to 0$), the pionic PCAC is used, which involves a much smaller extrapolation ($m_\pi \to 0$). From the presently available K_{e4} decay rate, the values of the I = 0 and 2S-wave pion-pion scattering length was estimated as $a_0 \simeq 0.18$ and $a_2 \simeq -0.017$. Although our numerical results for a_0, a_2, and the K_{e4}-decay form factors turn out to be not very different from those obtained by using the current commutation relations with soft-pion techniques, the important difference between the two approaches mentioned in (a) is emphasized with respect to the extrapolation procedures. (auth)

15782 OFF-MASS-SHELL MATRIX ELEMENT AND JACOBI IDENTITY. Fuchs, Norman H.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., 165: 1839-42(Jan. 25, 1968). (COO-1428-35).

A study is made on the conventional use of partial integration applied to divergences of currents in the off-mass-shell matrix elements regarding some of the external bosons. It is shown that equal-time commutators among currents and relevant operators must, in general, satisfy certain conditions in order for the above use of partial integration to be justified. In the case of the electromagnetic and/or weak matrix element in which two external bosons are made off the mass shell, the condition is that the Jacobi (commutator) identify holds for the relevant electromagnetic and/or weak operator and the time components of currents. In the case of the strong matrix element in which three external bosons are off the mass shell, the condition is that the Jacobi identity should be valid for some components of currents including both time and space components, and also for divergences. Explicit expressions are given for these off-mass-shell matrix elements when these identities are satisfied. (auth)

15783 CONNECTION BETWEEN THE WIGNER INEQUALITIES AND ANALYTICITY AND UNITARITY. Bonnier, B.; Mau, R. Vinh (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., 165: 1923-6(Jan. 25, 1968).

A lower bound on the momentum derivative of the phase shifts, $d\delta_l/dk$, is derived from the combination of unitarity, crossing, and analyticity (in the domain resulting from axiomatic field theory). As an application, a lower bound for the $\pi^0\pi^0$ scattering length is deduced. (auth)

15784 GROUPS FOR STATIC MULTISPIN MESON-SOURCE MODELS. I. Bhasin, V. S.; Pande, L. K. (International Atomic Energy Agency, Trieste, Italy). Phys. Rev., 165: 1927-33(Jan. 25, 1968).

Such generalizations of the static strong-coupling group as would incorporate multispin meson sources in place of the conventional p-wave source only are suggested. A model which contains both p- and d-wave sources but no internal symmetry is considered in detail. This serves to illustrate the essential arithmetic of the problem. Also, the results of this model are diretly adaptable to the corresponding group with isotopic-spin internal symmetry. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 15736 and 15779.

15785 (BNL-12058) FORWARD DISPERSION RELATIONS: THEIR VALIDITY AND PREDICTIONS. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Dec. 29, 1967. 64p. (CONF-671203-4). Dep. CFSTI.

From Conference on πN Scattering, Irvine, Calif.

The discussion of forward dispersion relations includes meson (π)–nucleon elastic scattering, meson (π)–nucleon forward dispersion relations, asymptotic bounds on total cross sections, early applications of forward dispersion relations, experimental measurements of π–N forward scattering amplitude, and a comparison of experimental results with the predictions of the π + N forward dispersion relations. Also considered are the fundamental length, charge independence, p + p and $\bar{p}$ + p forward scattering amplitudes and dispersion relations, and asymptotic theory. (J.F.P.)

15786 (CONF-670414-7) QUARK MODELS OF BARYON RESONANCES. Technical Report No. 680. Greenberg, O. W. (Maryland Univ., College Park. Dept. of Physics and Astronomy). May 1967. 23p.

From Meeting of the American Physical Society, Washington, D. C.

The bound-state quark model is assumed, and an attempt is made to determine how this model explains the baryon resonances. A phenomenological approach is used. Baryons are treated by introducing some parameters to characterize the various forces. Radial wave functions and potentials are not discussed since forces between quarks are unknown. The symmetry of the baryon wave function under permutations, mass formulas for the 56, higher supermultiplets, and mass formula for the $(\underline{70},1^-)$ are considered. (J.F.P.)

15787 (DESY-68/1) EIN REGGE-POL MODELL MIT ABSORPTIVEN KORREKTUREN FUER DIE REAKTIONEN $\pi^- + p \to \pi^0 + N$ UND $\pi^+ + p \to \pi^0 + \Delta^{++}$ (1238). (A Regge-Pole Model with Absorptive Corrections for the Reactions $\pi^- + p \to \pi^0 + N$ and $\pi^+ + p \to \pi^0 + \Delta^{++}$ (1238)). Schrempp, F. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Jan. 1968. 103p. (In German). Dep.

A Regge-pole model with absorptive corrections is presented for quasi-two-body reactions. It turns out that these corrections correspond to a cut contribution in the complex angular-momentum plane, with its branch point equal to the one resulting from two-Regge-pole exchange. πN-charge exchange and the reaction $\pi^+p \to \pi^0\Delta^{++}$ (1238) are studied in greater detail. In the case of πN-charge exchange, the s- and t-dependences of the recoil-neutron polarization are predicted in a satisfactory manner, especially if one uses a complex absorption factor resulting from a three-Regge-pole fit to the elastic πN scattering data. The kinematical t-singularities and zeros of the helicity amplitudes are not determined by the commonly used method, i.e., by the aid of the crossing relation, but rather by comparing the ρ-Regge-pole amplitudes with the corresponding ρ-meson-pole graph at $t \simeq m_\rho^2$. In the case of the reaction $\pi^+p \to \pi^0\Delta^{++}$ it is thus possible to isolate additional kinematical zeros at t = 0 and $t = (m_\Delta - m_N)^2$. Taking these zeros into account leads to rather weakly varying residues between t = 0 and $t = m_\rho^2$. The values of the residues determined from a fit to the data at t = 0, favor the assumption of a dominating M1-transition at the $N\rho\Delta$-vertex. Accordingly, the Δ^{++}-density-matrix elements exhibit only a weak t-dependence in the pure Regge-pole model. However, the absorptive corrections make the density-matrix elements substantially more t-dependent in good agreement with the data. (auth)

15788 (ITF-67-18) NAKHOZHDENIE RENORMALIZATSIONNOI AKSIAL'NOI KONSTANTY S POMOSHCH'YU RELYATIVISTSKI-INVARIANTNOGO URAVNENIYA DLYA SOSTAVNYKH CHASTITS. (Axial Constant Renormalization by Means of Relativistically-Invariant Quark Model). Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 11p. (In Russian). Dep.

An equation of the Bethe–Salpeter type was used for baryons as compound particles. A solution was obtained on the basis of the quasi-independent quarks. A formula for the renormalization of the axial constants, obtained by P. N. Bogolyubov, was derived. (tr-auth)

15789 (JINR-P2-3649) SOOTNOSHENIYA MEZHDU SECHENIYAMI NEUPRUGIKH PROTSESSOV RASSEYANIYA PRI BOL'SHIKH ENERGIYAKH. (Relations Between the Cross Sections of Inelastic Scattering Processes at High Energies). Enkovski, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 5p. (In Russian). Dep.

Relations connecting cross sections of the meson–baryon scattering at high energies of the type $0^- + \frac{1}{2}^+ \rightarrow 0^- + \frac{3}{2}^+$ are derived. (auth)

15790 (UH-511-17) RESONANCE PRODUCTION IN THE INTERACTION $\pi^- + p \rightarrow p + \pi^+ + \pi^-$ AT 3.9 GeV/c. Wohlmut, Peter G. (Hawaii Univ., Honolulu). Jan. 1968. Contract AT (04-3)-511. 53p. Dep. CFSTI.

Thesis.

A study has been made of the nonstrange, charged four-body final state π^- + proton interactions at 3.9 GeV/c incident momentum. It was found that resonance production dominates at this momentum, and that the data are consistent with a pure resonance model with kinematic phase space background. Significant fractions of single resonance production of ρ^0, $\Delta^{2+}(1236)$, $\Delta^0(1236)$, and the cascade resonances $A_1^- \rightarrow \rho^0 + \pi^-$, $A_2^- \rightarrow \rho^0 + \pi^-$, $N^{*+}(1450) \rightarrow \Delta^{2+}(1236) + \pi^-$, $N^{*+}(2650) \rightarrow \Delta^{2+}(1236) + \pi^-$ are essential for a good fit. Evidence is presented for the decay $\pi^-(1620) \rightarrow f^0(1250) + \pi^-$ and for an $I = \frac{3}{2}$ state in the $p\pi^-\pi^-$ system at 2650 MeV. Total cross sections are determined for each of the processes necessary for the fit to the data, and recommendations are made in regard to enlarging the resonance model to include both kinematic and dynamic effects. (auth)

15791 (UH-511-18) MESON AND BARYON RESONANCE PRODUCTION IN THE INTERACTION $\pi^-p \rightarrow p\pi^-\pi^-\pi^+\pi^0$ AT 3.9 GeV. Johnson, Alfred D. (Hawaii Univ., Honolulu). Jan. 1968. 39p. Dep. CFSTI.

Thesis.

Four thousand events fitting the five-body hypothesis $\pi^-p \rightarrow p\pi^-\pi^-\pi^+\pi^0$ were examined for resonance production using a maximum-likelihood method to fit the experimental data to a model of phase space weighted by Breit–Wigner functions. Parameters of the model are fractions of direct production of resonances (e.g., $\pi^-p \rightarrow \omega\pi^-p$) and cascade production (e.g., $\pi^-p \rightarrow A_2^0(1310)\,\pi^-p$, $A_2^0(1310) \rightarrow \rho\pi$). Masses and widths are not varied. Relative amounts of the important processes were determined, and although no one process dominates, it appears that the processes $H^0(1000) \rightarrow \rho\pi$, $N(1520) \rightarrow \Delta(1236) + \pi$, and $N(2190) \rightarrow \Delta(1236) + \pi$ must be included to achieve a reasonable fit. (auth)

15792 GENERAL FEATURES OF HIGH-ENERGY PROTON–PROTON AND PION–PION ELASTIC SCATTERING. McClure, J. A. (Tufts Univ., Medford, Mass). Nuovo Cim. (10), 53A: 921-32(Feb. 21, 1968).

Certain similarities in transverse momentum dependence between high-energy hadron elastic scattering and multi-pion production are pointed out. It is suggested these may be a consequence of unitarity, and a calculation with a simple model is done to explore this possibility. Among other things, these considerations suggest that the slope of the large-angle p-p elastic cross section is not constant, as has been thought, but that it decreases with energy. (auth)

15793 CANONICAL COMMUTATION RELATIONS AND ASYMPTOTIC BEHAVIOUR OF THE TRANSITION AMPLITUDES. II. Minguzzi, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 53A: 345-50(Jan. 21, 1968).

The problem of the subtractions in the πN dispersion relations is investigated by means of the canonical commutation relations in the limit of vanishing pion mass. It is proved that the symmetric πN amplitude require at most one subtraction and the antisymmetric one no subtractions. (auth)

15794 AN EXPANSION OF THE SCATTERING AMPLITUDE AT VANISHING FOUR-MOMENTUM TRANSFER USING THE REPRESENTATIONS OF THE LORENTZ GROUP. Toller, M. (CERN, Geneva). Nuovo Cim. (10), 53A: 671-716(Feb. 1, 1968).

The scattering amplitude at vanishing four-momentum transfer is expanded by means of the matrix elements of the irreducible representations of the Lorentz group including space reflection and the PCT transformation. These representations are labelled by a complex parameter λ and other "quantum numbers." The high-energy asymptotic behavior of the amplitude is assumed to be determined by the contributions of some poles in the complex λ-plane (Lorentz poles). The contribution of a Lorentz pole is decomposed into a family of Regge-pole contributions with given parities and signatures. The connection with other formalisms which give rise to families of Regge trajectories is briefly discussed. Particles with arbitrary spin and parity are considered. The selection rules for the quantum numbers of the Lorentz poles are treated in detail. The role of the internal symmetries and of the symmetry with respect to the permutation of identical particles is discussed. The general formalism is applied to the meson-nucleon and nucleon-nucleon scattering. (auth)

15795 SPACE–TIME SHIFTS AND CROSS SECTIONS IN COLLISIONS BETWEEN RELATIVISTIC WAVE PACKETS. Olkhovsky, V. S.; Recami, E. (Univ., Milan). Nuovo Cim. (10), 53A: 610-24(Feb. 1, 1968).

Motion and collision of relativistic wave packets are considered. Starting from space-time definitions of the experimental observables (cross sections, space-time shifts, etc.), their expressions are found in the energy-momentum representation, by using some Fourier-transformation techniques, thus generalizing some previous (non-relativistic) results to the case of two relativistic spin-zero interacting particles. It is noted that wave-packet spreading is often very large and cannot be neglected, as one usually does; but at the same time it is shown that the observable quantities do not commonly depend on spreading, blending or "smoothing." As an application, the time duration of some interactions at different energies is calculated. (auth)

15796 REGGE POLES AND SU(3): PARTICLE CLASSIFICATION AND HIGH-ENERGY SCATTERING. Barger, V. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Rev. Mod. Phys., 40: 129-39(Jan. 1968). (COO-881-112).

An integrated interpretation of the fundamental particle spectrum and the phenomena observed in high-energy scattering is possible within the framework provided by the SU(3) and Regge pole theories of strong interactions. Recent progress in this direction is reviewed with particular emphasis on qualitative predictions and experimental tests. The presence of forward and backward peaks in scattering angular distributions is associated with the existence of certain SU(3) multiplets of mesons and baryons that mediate the reactions as peripheral exchanges. The observed baryons are tentatively classified as Regge recurrences of 1-, 8-, and 10-dimensional SU(3) multiplets. For mesons, recurrences of only 1 and 8 representations are expected. Predictions for charge-exchange processes based on meson Regge exchanges are described in some detail. SU(3) symmetry for the vertices of the Regge exchanges leads to relations that agree with experiment. Scattering in the intermediate momentum range (1–4 BeV/c) is described in terms of an interference model which incorporates direct channel resonances as well as Regge exchange. Structure in forward $\pi^-p \rightarrow \pi^0n$ scattering and backward π^-p elastic scattering is interpreted by interference model calculations. (auth)

15797 REGGE-POLE DESCRIPTION OF ASSOCIATED PRODUCTION REACTIONS. Sarma, K. V. L.; Reeder, D. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nuovo Cim. (10), 53A: 808-12(Feb. 1, 1968). (COO-881-123).

Using a Regge-pole model based on the exchanges of $K^*(890)$ and $K^{**}(1420)$, the differential cross section and polarization for associated production were calculated. The specific reactions studied are $\pi^+ + p \rightarrow K^+ + \Sigma^+$, $\pi^- + p \rightarrow K^0 + \Sigma^0$, $K^- + p \rightarrow \pi^- + \Sigma^+$, and $\pi^- + p \rightarrow K^0 + \Lambda^0$. Exchange degeneracy is not assumed. (J.F.P.)

15798 K^+N SCATTERING AND THRESHOLD $N^*(1238)$ PRODUCTION. Krammer, M. (CERN, Geneva). Nuovo Cim. (10), 53A: 762-76(Feb. 1, 1968).

Experimental information on $N^*(1238)$ production around threshold in K^+p interactions is used to calculate the elastic $I = 1$ P-wave phase shifts by making use of the boundary condition model. The $P_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ phase shifts are found to be negative above 1 GeV/c kaon laboratory momentum. Furthermore, a model, made recently for the $K^0\pi^+p$ final state at 0.785 GeV/c is continued to higher momenta and compared to experiment. (auth)

15799 SYMMETRIC DESCRIPTION OF THE NUCLEON AND THE ROPER RESONANCE IN FIELD THEORY. Houard, J. C. (College de France, Paris); Hayot, F. Nuovo Cim. (10), 53A: 496-514(Jan. 21, 1968). (In French).

A model of a field theory is constructed in which the nucleon and the Roper resonance appear symmetrically, with the three couplings $NN\pi$, $NN^*\pi$ and $N^*N^*\pi$. Starting from the Lagrangian the compositeness conditions for the system are established. The model is used to calculate the $I = \frac{1}{2}$, $J = \frac{1}{2}^+$ πN-scattering amplitude and it is shown that the results obtained for the real phase shift are in resonable agreement with the phase-shift analyses. It is concluded that the Roper resonance may be considered as

composite. In this case, however, the pion-nucleon interaction Lagrangian contains an infinite number of coupling terms. (auth)

15800 LOW-ENERGY KAON–NUCLEON SCATTERING. Baba Pundari, S.; Dutta-Roy, B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 165: 1663-6(Jan. 25, 1968).

The successes of the current-algebra method and the vector-meson dominance approach for s-wave kaon-nucleon scattering lengths are taken to suggest the ansatz that in the absence of t-channel singularities, low-energy s-wave kaon-nucleon scattering is absent. This leads to certain sum rules with which kaon-baryon coupling constants are determined, which agree very well with other estimates. These values of the coupling constants are then found to give a satisfactory fit to low-energy kaon-nucleon s- and p-wave phase shifts. (auth)

15801 INTERPRETATION OF 2- TO 5-GeV/c $\pi^-p \rightarrow \pi^0n$ POLARIZATION DATA BY USE OF AN INTERFERENCE MODEL. Lamb, R. C.; Lundy, R. A.; Novey, T. B.; Yokosawa, A.; Yovanovitch, D. D. (Argonne National Lab., Ill.). Phys. Rev. Lett., 20: 253-5(Feb. 12, 1968).

The polarization in the $\pi^- + p \rightarrow \pi^0 + n$ interaction was studied at energies where the interference of one Regge-pole exchange in the t channel and resonances in the direct channel may be expected. It is found that the experimental data can be successfully interpreted according to the interference model. (L.B.S.)

15802 DETERMINATION OF KAON–NUCLEON COUPLING CONSTANTS FROM NEW MESON–NUCLEON DISPERSION RELATIONS. Chan, C. H.; Yen, W. L. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 165: 1565-7(Jan. 25, 1968).

Two superconvergent dispersion relations are proposed for the sum of three charge-conjugated meson-nucleon forward scattering amplitudes. These two sum rules can be evaluated exactly without using an approximation of saturation. They are obtained under the assumption that asymptotically the ρ pole couples to the pion and kaon universally. The sum rules are used for a determination of the kaon-nucleon coupling constants. (auth)

15803 CURRENT ALGEBRA AND THE SUPPRESSION OF RESONANCES WITH BARYON NUMBER 2. Avni, Y. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 165: 1574-8(Jan. 25, 1968).

The members of the 10 SU(3) multiplet, into which the deuteron (d) would have been classified in the limit of unitary symmetry, were not observed in experiments (apart from the deuteron itself). It is shown that current algebra and the hypothesis of partially conserved axial-vector current (PCAC) imply a suppression of the Λ^0K^-d strong vertex, where Λ^0 is a dibaryon state in the aforementioned $\overline{10}$. It is therefore suggested that the other particles of that multiplet were not observed because of their small coupling to the states being used in the experiments. (auth)

15804 ALGEBRA OF CURRENT COMPONENTS AND THE HYPOTHESIS OF PARTIALLY CONSERVED AXIAL-VECTOR CURRENT APPLIED AT HIGH ENERGIES. Olesen, P. (Univ. of Copenhagen). Phys. Rev., 165: 1682-93(Jan. 25, 1968).

Using the hypothesis of partially conserved axial-vector currents, the algebra of current components, and the assumption that the pion-hadron total cross section $\sigma(s)$ approaches its asymptotic value rapidly, a method is developed which allows a calculation of the elastic amplitude at high energies and small momentum transfers. This method uses the fact that asymptotically the dynamics is given by the commutator on the light cone. The results are $\sigma_{\pi p}(\infty) = 25.7 \pm 4.2$ mb and $d\sigma/dt)_{t=0}[G_E^2 - (t/4M^2)G_M^2](1 - t/4M^2)^{-1}$ (for small values of the momentum transfer t), where $G_E(t)$ and $G_M(t)$ are the electric and magnetic form factors of the proton. It is shown that possible Schwinger terms in the equal-time commutators are without importance for our results. An important feature of our calculation is that the energy and the momentum are allowed to go to infinity simultaneously; our method therefore deviates essentially from the Bjorken limit, which in general involves a continuation of the amplitude infinitely off the mass shell. (auth)

15805 POMERANCHUKON EXCHANGE IN INELASTIC TWO-BODY REACTIONS. Morrison, Douglas R. O. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 165: 1699-1702(Jan. 25, 1968). (BNL–11681).

Inelastic two-body and quasi-two-body reactions are classified phenomenologically. A class of events which could be interpreted as exhibiting Pomeranchukon exchange is identified. The conditions for such Pomeranchukon exchange are studied and in the production of a resonance from an incident particle, the change in spin ΔJ, and the change in parity ΔP, are found empirically to obey the relation $\Delta P = (-1)^{\Delta J}$. (auth)

15806 VACUUM EXPECTATION VALUES OF THE BARYON CURRENTS AND THEIR SYMMETRY. Kuo, T. K. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 165: 1708-13(Jan. 25, 1968). (COO–1428-37).

The spectral representations for the vacuum expectation value of the baryon currents are studied. A "chiral symmetry" between the baryon currents and axial baryon currents is assumed in the form of "asymptotic symmetry." This leads to sum rules involving the spectral functions for the baryon currents. In much the same way as has been done with vector and axial-vector currents, an attempt is made to saturate the obtained sum rules with baryon resonances. Constraints on the baryon mass spectrum (with J^P values $\frac{1}{2}^+$ and $\frac{3}{2}^+$) are deduced. Fair agreement is obtained in two possible cases: (1) the Y = 0, I = 1 Y_1^* system; (2) the Y = −1, I = $\frac{1}{2}\Xi_{\frac{1}{2}}^*$ system. (auth)

15807 PHASE-SHIFT ANALYSIS OF PION–NUCLEON ELASTIC SCATTERING BELOW 1.6 GeV. Bareyre, P.; Bricman, C.; Villet, G. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev., 165: 1730-49(Jan. 25, 1968).

A phase-shift analysis of π-nucleon elastic scattering has been developed, one energy at a time, up to 1.6-GeV pion kinetic energy. This analysis differs from a previous one in that final experimental data and new polarization measurements are included. Particular care has been taken to have a coherent set of data (2170 experimental points). In addition to the known important effects, the phase shifts of the solution have oscillations coming from the experimental data. It is not possible to say whether the oscillations are due to experimental biases or to physical effects. This analysis is consistent with the one presented by Lovelace at the Thirteenth Berkeley Conference. (auth)

15808 K^+p PHASE-SHIFT ANALYSIS BELOW 1500 MeV/c. Lea, A. T. (Rutherford High Energy Lab., Chilton, Eng.); Martin, B. R.; Oades, G. C. Phys. Rev., 165: 1770-86(Jan. 25, 1968). (BNL–11699).

An extensive systematic energy-dependent phase-shift analysis in the kaon laboratory momentum range 140 to 1495 MeV/c was made of K^+p scattering data, supplemented by information from K^+p forward dispersion relations. S, P, and D waves were included, and various assumptions were made concerning the source of the inelasticity. Results are presented for solutions allowing all possible combinations of up to three partial waves to be inelastic. Four basic types of solution are found, and experiments are suggested which will best help to decide among them. Two of these groups of solutions show some evidence for a resonance in the $P_{\frac{1}{2}}$ partial wave, although its precise characteristics cannot be determined with present data. (auth)

15809 SUPERCONVERGENCE AND THE $Y_0^*(1405)BP$ COUPLING. Biswas, S. N.; Bose, Subir; Datta, K.; Dhar, J.; Saxena, R. P. (Univ. of Delhi). Phys. Rev., 165: 1788-90 (Jan. 25, 1968).

Fixed-momentum-transfer dispersion relations are considered for the process $\bar{K} + N \rightarrow \Sigma + \pi$. Under the assumption that the asymptotic behavior of the amplitude at high energies is governed by the Regge trajectories in the crossed t channel $K + \pi \rightarrow \bar{\Sigma} + N$, a sum rule is obtained which allows the Y_0^*BP coupling to be estimated. The calculated value agrees well with the estimate by Dalitz, Wong, and Rajasekharan, and that by Das and Mahanthappa. (auth)

15810 POSSIBLE EXISTENCE OF A SPIN-2 REGGE RECURRENCE OF THE $^1S_0$ p–p POLE (THE UNBOUND DIPROTON). Arndt, Richard A. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 165: 1834-8(Jan. 25, 1968). (UCRL–70462).

A model is developed wherein the $^1D_2$ p-p partial-wave amplitude is coupled through N/D equations to a second, inelastic channel containing a proton and a second particle in a relative S wave. The mass of the second particle is "smeared out" according to an appropriate Breit–Wigner form around the (3,3) resonance at 1260–1120 MeV. The phenomenological potential is adjusted to fit the elastic $^1D_2$ phase shift to 400 MeV and the existing imprecise data at 660 MeV. The model, when adjusted to fit experiment, predicts a pole on the second Riemann sheet at 400–1300 MeV. This pole may be interpreted as a bound state in the inelastic channel and has quantum numbers (I = 1, B = 2, J = 2) consistent with the spin-2 Regge recurrence of the pole in the $^1S_0$ amplitude, the "unbound" diproton. An alternative coupled-channel model is developed which fits the elastic data but which does not predict the pole. The high-energy predictions for elastic scattering which are derived from the second model are found to differ drastically from those of the first model and from the predictions of various theories for high-energy inelastic processes. (auth)

15811 POLES AND RESONANCES IN η PRODUCTION. Deans, S. R.; Holladay, W. G. (Vanderbilt Univ., Nashville). Phys. Rev., 165: 1886-92(Jan. 25, 1968).

Poles and resonances are used to find χ^2 fits to the data up to several hundred MeV above threshold for the processes $\pi^- + p \rightarrow n + \eta$ and $\gamma + p \rightarrow p + \eta$. Below center-of-mass energy W = 1700 MeV, a consistent picture of these reactions is achieved with the following ingredients: a nucleon pole and $P_{11}(1400)$, $S_{11}(1570)$, and $D_{13}(1512)$ resonances for production by pions; a nucleon pole, a vector meson pole, and $S_{11}(1570)$ and $D_{13}(1512)$ resonances for photoproduction. Some $F_{15}(1688)$ also improves the fits. The value of the η-nucleon coupling constant, $g_{\eta}^2/4\pi$ is $\lesssim 0.002$ in both processes. Implications of these results for quark models and SU(3) symmetry are discussed. Above W = 1700, possible additional resonances are considered in η production by pions. (auth)

15812 A COMPOSITE MODEL OF THE Σ HYPERON. Calpacas, Anna J. Rochester, N. Y., Univ. of Rochester, 1967. 196p.

Thesis.

A simple composite picture for the Σ hyperon is considered. The Σ is taken to be a mixture of bound $\Lambda\pi$ and $N\bar{K}$ pairs. The other fundamental assumptions of the model are the validity of unsubtracted dispersion relations for composite vertices with an elementary particle off the mass shell and of a ladder approximation to the Bethe–Salpeter equation. The model only attempts to determine gross features of the Σ, since the approximations made do not do justice to the detailed structure of the particle. Dispersion relations are set up for the $\Sigma\Lambda\pi$ and $\Sigma N\bar{K}$ form factors with the bosons off the mass shell. The equations are then transformed into homogeneous algebraic equations for the effective coupling constants $g_{\Sigma\Lambda\pi}$ and $g_{\Sigma N\bar{K}}$. Two values for the ratio $x = g_{\Sigma^+N\bar{K}}/g_{\Sigma^+\Lambda\pi}$ are obtained. The requirement that they coincide eliminates the presence of a cutoff. The $\Sigma\Lambda\pi$ and $\Sigma N\bar{K}$ form factors are again considered, but with the elementary baryon masses dispersed, and another value of x is obtained, which is not very different from the previous one. $|x|$ as determined previously is close to unity, practically independently of the input value of $g_{AN\bar{K}}$. The sign of x is opposite to that of the product of coupling constants $g_{NN\pi}\, g_{AN\bar{K}}$. Isospin invariance of the elementary interactions leads to isospin invariance for the induced Σ interactions. An order of magnitude estimate of $|g_{\Sigma\Lambda\pi}|$ is attempted in using the relation between Bethe–Salpeter amplitudes and composite vertices and the Cutkosky–Leon normalization condition on the former. A crude approximation predicts $8.7 \lesssim |g_{\Sigma\Lambda\pi}| \lesssim 10.7$ for $5 \lesssim |g_{AN\bar{K}}| \lesssim 13.5$. Finally, the model is applied toward a dispersion theoretic evaluation of the on-shell $\Sigma^0\Lambda^0\gamma$ form factors. The $\Sigma\Lambda$ transition moment is found to be approximately equal to $g_{AN\bar{K}}(g_{\Sigma^+N\bar{K}}/\sqrt{2})\ 10^{-2}$ nuclear magnetons. The Dirac form factor vanishes on the mass shell, and the form factor which would vanish in the limit of equal Σ^0 and Λ^0 masses turns out to be two orders of magnitude smaller than the transition moment. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 15779, 15792, and 15794.

15813 (JINR-E2-3638) ANALYSIS OF THE PERIPHERAL MODEL FOR THE PROCESS $p + p \rightarrow p + n + \pi^+$ AT 0.5 TO 0.7 GeV. Suslenko, V. K.; Kochkin, V. I. (Joint Inst. for Nuclear Research Dubna (USSR). Lab. of Nuclear Problems). 1967. 25p. Dep.

The comparison of theoretical calculations performed on the basis of peripheral model taking into account the energy and momentum conservation laws by using the convenient reference system (L_R-system) was made with π^+-meson experimental data for the process $p + p \rightarrow p + n + \pi^+$ at incident energies T = 556 and 660 MeV and different lab angles. As a consequence of good qualitative agreement the applicability of the peripheral model concepts in the given energy region was shown to be possible. (auth)

15814 PRODUCTION OF ρ^0 AND ω^0 IN HIGH-ENERGY PROTON-PROTON COLLISIONS. Roberts, R. G. (CERN, Geneva). Nuovo Cim. (10), 53A: 557-60(Jan. 21, 1968).

A simple mechanism in the double Regge-pole model is suggested that inhibits the production of ρ^0 in favor of ω^0 in high-energy proton-proton interactions. The behavior of the differential cross section for ω^0 production is shown in comparison with the data from a recent counter experiment at 12.3 GeV. (L.B.S.)

15815 THEORETICAL TREATMENT OF THE ELASTIC AND INELASTIC SCATTERING OF 1-GeV PROTONS FROM NUCLEI. Lee, H. K. (Duquesne Univ., Pittsburgh); McManus, H. Phys. Rev. Lett., 20: 337-40(Feb. 12, 1968).

A calculation is presented using the WKB impulse approximation for both the elastic and inelastic scattering of 1-GeV protons from ^{12}C and ^{16}O, using microscopic form factors for the inelastic scattering from excited states of ^{12}C and ^{16}O. The cross sections are compared with those obtained by the Glauber series method. (L.B.S.)

15816 REGGE THEORY OF HIGH-ENERGY SCATTERING WITH RELATIVELY LARGE MOMENTUM TRANSFER. Sawada, Tetsuo (Tokyo Univ.). Phys. Rev., 165: 1848-56(Jan. 25, 1968).

Functional equations for the Regge parameters $\alpha(t)$ and $\beta(t)$ are derived from the unitarity condition, which is valid for relatively large momentum transfer. By solving these equations the high-energy cross section with relatively large momentum transfer are computed up to two arbitrary periodic functions. The result agrees with Orear's fit except for the appearance of dips This result is compared with high-energy experiments on p-p scattering with large momentum transfer, and some prediction is made concerning the position of the dips. (auth)

15817 PHENOMENOLOGICAL PHASE-PARAMETER FITS TO N–N DATA UP TO 350 MeV. Seamon, R. E.; Friedman, K. A.; Breit, G.; Haracz, R. D.; Holt, J. M.; Prakash, A. (Yale Univ., New Haven). Contract AT(30-1)-1807. Phys. Rev., 165: 1579-86(Jan. 25, 1968). (YALE–1807-42; YALE–1807-48).

Results of phenomenological phase-parameter fits intended primarily for energies between somewhat below 10 and 350 MeV are presented in the form of tables suitable for interpolation. Comparisons of the pion-nucleon coupling constant as derived from p-p and n-p scattering data are made. Indications of a difference in the value of this constant are obtained. Though relatively small, this difference is outside the apparent statistical uncertainty of the determination. Some possible reasons for the difference are briefly discussed. A total of 1988 experimental data has been used. Corrections for the effect of nucleon magnetic moments, for Coulomb effects, and for short-range charge dependence are included. (auth)

15818 COMPARISON BETWEEN AN OFF-SHELL PERTURBATIVE METHOD AND THE ON-SHELL DASHEN–FRAUTSCHI METHOD. Marchesini, G. (Univ. of Milan). Phys. Rev., 165: 1703-7(Jan. 25, 1968).

An off-shell method of calculating the effects of a small perturbation on the discrete and the continuous spectrum of a two-particle system is developed. The derivation, made in a nonrelativistic context, lends itself to easy extension to some relativistic models. The method, by means of which both short- and long-range perturbations can be handled, is then applied to simple models to test the reliability of the Born approximation to the Dashen-Frautschi (DF) perturbative formula. First the convergence for short-range perturbations is tested. It is found that both perturbative methods are rapidly convergent, unless a virtual state is near the physical thereshold. Second, the results are compared: The scattering-length shifts calculated by the DF formula in the Born approximation and by the off-shell formula are of the same order of magnitude for a crude model of NN interaction. Finally, long-range (Coulomb) perturbations are tested. If in the DF formula the first-order change in the amplitude is approximated by the contribution of the one-photon exchange, the binding energy shift is different by a factor of ten in magnitude from the corresponding off-shell value. Furthermore, the off-shell value seems less sensitive to the high-energy structure of the form factor than the on-shell value is. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 15336, 15708, and 15709.

15819 (JINR–P2-3648) NELINEINYE PREDSTAVLENIYA GRUPPY SU(2). (Non-Linear Representations of the SU(2) Group). Stoyanov, D.; Khristov, Khr. Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 30p. (In Russian). Dep.

Nonlinear representations of the SU(2) group are classified. It is shown that the number of irreducible unequivalent nonlinear representations of SU(2) is finite and any representation, the dimensionality of which is larger than 3, is reducible. (auth)

15820 CHARACTERS OF SEMI-SIMPLE LIE GROUPS. Harish-Chandra (Inst. for Advanced Study, Princeton, N. J.). pp 137-42 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

The group G, which is a compact, topological and connected semi-simple Lie group, is considered. If π is a finite-dimensional irreducible unitary representation of G, then the function θ_π is called the character of π and is defined as $\theta_\pi(x) = \mathrm{Tr}\ \pi(x)$ ($x \epsilon G$). The properties of θ_π are discussed. (J.F.P.

15821 INTERNAL COORDINATES AND EXPLICIT REPRESENTATIONS OF THE POINCARE GROUP. Kihlberg, A. (CERN, Geneva). Nuovo Cim. (10), 53A: 592-609(Feb. 1, 1968).

Using a certain co-ordinate space (which is an extension of the Minkowsky space) as a carrier space explicit positive mass representations of the Poincaré group are derived. Besides that the procedure illustrates the peculiarity of the Dirac equation, it is intended as a first step in trying to develop an elementary particle theory where the spin plays a more pronounced role in the interaction process. (auth)

15822 COUPLING PROBLEM FOR U(p,q) LADDER REPRESENTATIONS. II. LIMITATIONS ON THE COUPLING OF U(p,q) LADDERS. Anderson, R. L.; Raczka, R. (International Center for Theoretical Physics, Trieste, Italy). Proc. Roy. Soc. (London), Ser. A, 302: 501-8(Jan. 23, 1968).

It is shown that for any assignment of the physical multiplets to U(p,p) ladders consistent with the U(6,6) type of particle conjugation, the tensor product of two physical ladders does not contain any ladder. Therefore, it is impossible to construct an invariant Yukawa-type interaction term. (auth)

15823 NONDYNAMICAL TESTS OF THE CPT THEOREM AND RELATED SYMMETRIES. Csonka, Paul L.; Moravcsik, Michael J. (Univ. of California, Livermore). Phys. Rev., 165: 1915-22(Jan. 25, 1968).

It is shown that nondynamical tests of PT invariance and of the CPT theorem both involve mirror relations as well as nonmirror relations; their form is given in detail. The nonmirror relations for the two types of invariances are closely related. Several specific reactions are discussed in detail to illustrate the results. (auth)

15824 HIGHER SYMMETRY GROUPS AND ELEMENTARY PARTICLES. Tunkelang, Ben Zion. New York, Yeshiva Univ., 1967. 141p.

Thesis.

The elementary particles are assigned to the different representations of SU_3. The compatibility of the unitary octet mass formulates with electromagnetic mixing are analyzed. This analysis gives a quantitative tool to investigate the validity of the perturbation approach in the derivation of mass formulas. One of the octet mass formulas is found to be incompatible with the electromagnetic mixing. New mass formulas are derived for the 27-dimensional representation by expanding the matrix elements of vanishing multiple commutators. These formulas hold to second order in the medium strong and electromagnetic interaction and to the lowest cross-term (YQ^2) between them. The elementary particles are assigned to the representations of G_2; the intrinsic CA symmetry of this group is defined and its consequences compared to the A symmetry postulated by Bronzan and Low for the SU_3 scheme. Use is also made of current algebra methods to derive sum rules for the vector and axial currents in G_2. The elementary particles are assigned to the representations of B_3, a rank three group. Many of the SU_3 and the G_2 properties are recovered by the B_3 assignment of particles. Also the π^+, λ^+, χ^+ mixing in B_3 is analyzed with the purpose of explaining the large experimental K^+, π^+ mass difference. Relations among the three point vertex functions are derived and finally a weak current theory in B_3 is outlined. (Disser. Abstr.)

15825 ON HIGHER SYMMETRIES AND MASS SPECTRUM OF ELEMENTARY PARTICLES. Koh, Chor Jin. Boston, Boston Univ. Graduate School, 1967. 69p.

Thesis.

It was suggested previously that the mass-splitting on a multiplet of elementary particles may arise from the existence of certain higher symmetry, possibly a nontrivial combination of the internal and the external symmetries. The possibility of obtaining a mass spectrum on such grounds is examined, using group theoretical methods. The following results are obtained. In the representation space of the combined symmetry group G, the eigenvalue of the mass operator is unique, provided that: G contains the Poincaré group as a subgroup; and the mass operator is taken to be $P_\mu P_\mu$, where P_μ are the generators of translations. G is a Lie group of finite order. The representation space is unitary, and furthermore is physically acceptable, in the sense that the generators of G are realized by linear operators in the representation space D(L). If instead of the Poincaré group, the deSitter group is considered to be the group of external symmetry, then the mass operator (which is usually identified with the Casimir operator of the deSitter group) can have different eigenvalues under the same restrictions made above on G and the representation space. But the differences are too small to account for the actual mass-splitting of a multiplet. However, if one accepts a modified mass operator then mass-splitting of the right order can be obtained. Some effect of the structure of the group G on the mass spectrum is also discussed. (Disser. Abstr.)

Applications (Electromagnetic and Weak)

15826 CONSERVED VECTOR CURRENTS AND BROKEN SYMMETRIES. Meyer, Ph. (Univ., Paris). pp 13-21 of Symposia on Theoretical Physics, Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

Previous work on the problem of the renormalization of the coupling constant of the weak vector currents, essentially the strangeness-changing current, when the symmetry which leads to a conservation law is broken is briefly discussed. The main result is that under rather general conditions there is no renormalization to first order in the symmetry-breaking interaction. (J.F.P.)

15827 NONLEPTONIC DECAYS IN HIGHER SYMMETRIES AND MASS-SPLITTING INTERACTION. Gupta, S. N. (Univ. of Roorkee, India). Nuovo Cim. (10), 53A: 547-51(Jan. 21, 1968).

The derivation of sum rules for S-wave and P-wave nonleptonic decays of hadrons in SU(6) and $SU(6)_W$ is illustrated in order to point out that the SU(3) mass-splitting interaction must be taken into account. (L.B.S.)

15828 CP-CONSERVING DECAY $K_1^0 \to \pi^+\pi^-\pi^0$. Eliezer, Shalom; Singer, Paul (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., 165: 1843-8(Jan. 25, 1968).

The part of the weak Hamiltonian responsible for the CP-conserving decay $K_1^0 \to (3\pi)_{I=0}$ is constructed phenomenologically from three-meson-field products. With the aid of this Hamiltonian the process $K^{+,0} \to \pi^{+,0}l^+l^-$ as well as the P-wave parts of various $K \to 3\pi$ decays are discussed. For the CP-conserving decay $K_1^0 \to (3\pi)_{I=0}$ a decay ratio $K_1^0 \to 3\pi / K_2^0 \to 3\pi \simeq 10^{-7} - 10^{-6}$, is estimated. (auth)

Applications (Strong)

15829 MULTIPLET STRUCTURE AND MASS SUM RULES IN SU(6) SYMMETRY SCHEME. Singh, Virendra (Tata Inst. of Fundamental Research, Bombay). pp 23-33 of Symposia on Theoretical Physics, Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

The multiplet assignments of various observed particles in the SU(6) symmetry scheme are discussed, and it is found that SU(6) is very satisfactory for these multiplet assignments. Also sum rules which hold in the presence of symmetry-breaking interactions are discussed for the masses of the various multiplets of SU(6). (J.F.P.)

15830 $SL_{6,C}$ AND THE WEINBERG FORMALISM FOR SPIN-s PARTICLES. Shay, D. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim. (10), 53A: 1039-44(Feb. 21, 1968).

It is shown that the Weinberg formalism can be used to combine Lorentz and SU(3) symmetries. A fundamental multiplet or quark is defined, which is used to build up real particle fields. The fields, which are multiplets of $SL_{6,C}$, are used to construct unique three-meson and Yukawa vertices which are described by $SL_{6,C}$ and parity-invariant Lagrangians. (L.B.S.)

15831 ON THE TRANSFORMATION FROM O_3 TO $O_{2,1}$ BASES IN $SL_{2,C}$. Akyeampong, D. A.; Boyce, J. F.; Rashid, M. A. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 53A: 737-44(Feb. 1, 1968).

The overlap function from O_3 to $O_{2,1}$ basis vectors for unitary representations of $SL_{2,C}$ group obtained originally by Sciarrino and Toller is recast as a finite series of products of Γ-functions. This has the advantage of simplifying explicit calculations of the overlap function for cases of practical interest. The use of the formula for the case of forward NN scattering is illustrated. (auth)

15832 ALGEBRAIC CLASSIFICATION OF REGGE POLES. Domokos, Gabor; Tindle, Graham L. (Univ. of California, Berkeley). Phys. Rev., 165: 1906-14(Jan. 25, 1968).

Starting from the Lorentz invariance and usual on-mass-shell analyticity properties of scattering amplitudes, it is proved that: (a) massless "particles," transforming according to infinite-spin

representations of the two-dimensional Euclidean group, are necessarily "elementary," corresponding to Kronecker-δ singularities in the j plane; (b) the classification algebra of Regge poles, at vanishing invariant mass, is necessarily the Lie algebra of the homogeneous Lorentz group SL(2,C). The contributions of Regge poles to scattering amplitudes of particles with arbitrary finite mass and spin at vanishing momentum transfer are calculated, taking into account the "conspiracy" of Regge poles arising from their classification according to SL(2,C). The Regge contributions are indeed found to have the required analyticity properties and, therefore, a uniform asymptotic behavior for large energies. (auth)

15833 EVEN-PARITY MESON RESONANCES. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 165: 1899-1905(Jan. 25, 1968).

A recent model of the odd-parity baryon resonances is extended to include even-parity meson resonances. The resonances are assumed coupled to S-wave and D-wave MM states (where M denotes a pseudoscalar or vector meson) with interaction constants such that the resonance pole contributions to the collinear MM → MM scattering amplitudes satisfy $SU(6)_W$ symmetry. The relative coupling of the 35-fold and 1-fold M representations is taken in accordance with a bootstrap model. The set of even-parity resonances predicted in this model are octets of $j^C = 0^+$, 1^+, 2^+, and 1^-, and 0^+, 2^+, and 1^- singlets, where C is the particle-antiparticle conjugation quantum number of the $I_3 = Y = 0$ particles. The partial widths for MM decays and the principal terms in the mass splitting are computed in the model. The agreement with the present experimental data is good. (auth)

15834 TOWARD A VECTOR MESON BOOTSTRAP IN $\bar{B}B$ SCATTERING. Palmer, William Franklin. Baltimore, Johns Hopkins Univ., 1967. 152p.

Thesis.

An analysis is made of the coupled S-wave and D-wave $\bar{B}B$ scattering amplitudes. SU(3) symmetry is assumed. The analytic properties attributed to the amplitudes are those developed by Goldberger, Grisaru, MacDowell and Wong. Cross symmetry is approximately satisfied by including in the t-channel (exchange singularities) the same particles which are expected in the s-channel (annihilation singularities). The coupled amplitudes are made unitary, within the elastic approximation, by including in the singlet and octet scattering matrices all possible coupled SU(3) and $J^P = 1^-\bar{B}B$ states. The problem is formulated in terms of a matrix set of coupled integral equations which are linearized by the ND^{-1} method. Approximation is used and bootstrap solutions are sought in analogy to the Zachariasen bootstrap of the ρ-meson in ππ scattering. Bound state solutions are found in the SU(3) singlet and octet amplitudes corresponding to the observed nonet of vector mesons. The bound state solutions can be made self-consistent in mass. Predictions are made for the vector meson-baryon coupling constants. Questions of residue self-consistency are investigated; sensitivity and uniqueness of the solutions are discussed. Finally, inelastic effects are considered and improvements to the calculation are suggested. (Disser. Abstr.)

Field Theories

General

15835 CURRENT COMMUTATION RELATIONS AND CONTINUOUS TENSOR PRODUCTS. Streater, R. F. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 53A: 487-95(Jan. 21, 1968).

A method is proposed for constructing tensor products of representations of Lie groups over a continuous variable such as a space co-ordinate. This gives realizations of the equal-time commutation relations of a quantized current density, which generates local transformations of any Lie group G. The operators act in a linear space furnished with a "scalar product," which however is not always nonnegative. If $G = SU_2$ an indefinite "metric" in the ferromagnetic representation is obtained, and if G = Heisenberg-group the usual Fock representation is obtained, which of course has got a positive metric. Finally by a change of localization the usual free relativistic quantized boson field is obtained. (auth)

Quantum Field Theory

Refer also to abstracts 15647, 15693, 15697, and 15731.

15836 (ITF-67-24) O FORMULIROVKE ADIABATICHESKOI GIPOTEZY V AKSIOMATICHESKOI TEORII POLYA. (Formulation of the Adiabatic Hypothesis in Axiomatic Field Theory). Medvedev, B. V.; Polivanov, M. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 12p. (In Russian). (CONF-670544-6). Dep.

From Conference on Axiomatic Quantum Field Theory and Elementary Particles, Kiev, USSR.

Certain prescriptions which are equivalent to the adiabatic hypothesis are formulated in the framework of axiomatic approach. The eventual occurrence of the δ-function derivatives in coefficient functions in renormalized theories makes them necessary. (auth)

15837 ON GOLDSTONE'S THEOREM. Lopuszanski, Jan T. (Univ., Wroclaw). Fortschr. Phys., 15: 681-704(1967).

The conventional formulation of Goldstone's theorem is reviewed. The shortcomings of the conventional approach are pointed out, with the aim to show how they can be avoided by applying a rigorous algebraic approach. A short review is given of some notions used in the algebraic theory of quantum field theory as a preliminary to giving a precise definition of spontaneous breakdown of symmetry. The algebraic approach to a complex of problems related to Goldstone's theorem is outlined. (L.B.S.)

15838 LAGRANGIAN FIELD THEORY IN TERMS OF GREEN'S FUNCTIONS. II. THEORY OF SELF-GENERATING INTERACTIONS. Englert, F. (Univ. Libre, Brussels); De Dominicis, C. Nuovo Cim. (10), 53A: 1021-38(Feb. 21, 1968).

A set of independent variables, called stripped correlation functions, closely related to Green's functions, are introduced to characterize a given field theory. The parameters of the theory, which describe the interaction between fields (interaction potentials), are expressed in terms of these variables. The equations obtained by putting all the interaction potentials equal to zero are shown to be derivable from a stationarity principle on vacuum fluctuations with respect to stripped correlation functions. The resulting theory of self-generating interactions is discussed and it is shown that in such a theory single-particle propagators are not renormalized. These results are examined in connection with "bootstrap" theories and with a "quark" model of elementary particles. (auth)

15839 LAGRANGIAN FIELD THEORY IN TERMS OF GREEN'S FUNCTIONS. I. GENERALIZED PERTURBATION THEORY AND INVERSION THEOREMS. Englert, F. (Univ. Libre, Brussels); De Dominicis, C. Nuovo Cim. (10), 53A: 1007-20(Feb. 21, 1968).

The problem of self-generating interactions in Lagrangian field theory is discussed in the introduction which serves as a presentation for both papers on this subject. In this first a formal perturbation theory is presented in terms of linked diagrams, about an arbitrary unperturbed system characterized by all its Green's functions. Using this expansion, a complete formulation of Lagrangian field theory is presented and proved in terms of Green's functions. The parameters of the theory (potentials) are expressed in terms of the Green's functions through Feynman diagrams. The results are interpreted in terms of a "dual" action operator, containing as potentials the connected Green's function. The relevance of this formulation to the problem of self-generating interactions is emphasized. (auth)

15840 EXTENSION OF THE RENORMALIZATION GROUP. Astaud, M. (Institut Henri Poincare, Paris); Jouvet, B. Nuovo Cim. (10), 53A: 841-54(Feb. 21, 1968). (In French).

The usual renormalization group $G(Z_3)$ is constructed, assuming only that the "group" structure follows from the existence of a fundamental invariant. If other invariants are suitably chosen, it is then possible to build extensions of the renormalization "group," $G(Z_3, Z_2, Z_2', Z_1, Z_1')$. A detailed investigation is made of the "group" $G(Z_3, Z_2')$, and it is used to obtain the asymptotic behavior of electron and photon self-energy graphs grouped into classes characteristic of the chosen invariant. (auth)

15841 A HOMOLOGICAL APPROACH TO PARAMETRIC FEYNMAN INTEGRALS. Boyling, J. B. (Cambridge Univ., Eng.). Nuovo Cim. (10), 53A: 351-75(Jan. 21, 1968).

The methods of homology theory are applied to Feynman integrals in α-space. In the case of single-loop graphs the relevant relative homology groups are computed and the results compared with those obtained by k-space methods. For graphs with more than one loop the permanent pinch difficulty is overcome by modifying the ambient manifold and applying Thom's isotopy theorem. Pinching conditions are then found for Landau singularities in which complete circuits are contracted out and for mixed second-type singularities. The breakdown of the hierarchical principle in perturbation theory is also explained from this point of view. (auth)

15842 FUBINI IDENTITIES FOR FEYNMAN DIAGRAMS. Osborne, P.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nuovo Cim. (10), 53A: 538-43(Jan. 21, 1968).

Fubini-type identities are studied in the Feynman-diagram model of relativistic quantum mechanics using Ward-identity type

arguments. Covariant relations with no Schwinger-term contributions are found for currents constructed from Fermi fields, but covariant Schwinger terms are in general present if Bose fields are used to construct the currents. Finally the PCAC assumption is discussed. (auth)

15843 STOCHASTIC INTERACTING FIELD. Canfield, J. M. (Univ. of Oklahoma, Norman). Contract NGR-37-003-026. Nuovo Cim. (10), 53A: 515-21(Jan. 21, 1968).

An interacting scalar quantum field formalism is examined in which a kinematical dependence on stochastically averaged space-time co-ordinates is required. A necessary condition that the interacting field satisfy canonical equal-time commutation relations is derived. Since a unitary connection between free and interacting fields is not forbidden in stochastic theory, a prescription for the time-translation operator V(t) is obtained. (auth)

15844 ELECTROMAGNETIC INTERACTION OF THE BARGMANN–WIGNER FIELDS. Gupta, Suraj N.; Repko, Wayne W. (Wayne State Univ., Detroit). Phys. Rev., 165: 1415-19 (Jan. 25, 1968).

It is proposed that the electromagnetic interaction in the Lagrangian formalism for the Bargmann–Wigner fields should be introduced in such a way that the number of linearly independent components of the auxiliary fields is minimized in the resulting field equations. In this way a consistent formulation of the electromagnetic interaction of the Bargmann–Wigner field with spin $^3/_2$ is obtained, and its equivalence with the Rarita–Schwinger formulation is established. (auth)

15845 ANOMALOUS AND NORMAL SINGULARITIES AND THE INFINITE-MOMENTUM LIMIT. Susskind, Leonard; Frye, Graham (Yeshiva Univ., New York). Phys. Rev., 165: 1553-4(Jan. 25, 1968).

The behavior of the intrinsic size of a bound state as a function of its mass is derived by using an analogy between nonrelativistic two-dimensional quantum mechanics and the infinite-momentum limit of relativistic quantum theory. (auth)

15846 SOLVABLE TWO-DIMENSIONAL FIELD THEORY BASED ON CURRENTS. Callan, C. G. (Harvard Univ., Cambridge, Mass.); Dashen, R. F.; Sharp, D. H. Contract AT(30-1)-2171. Phys. Rev., 165: 1883-6(Jan. 25, 1968). (NYO–2171-232).

A study is made of a solvable 2-dimensional field theory specified by a closed equal-time algebra generated by commutation of the components of the electric current and the energy-momentum tensor $\theta_{\mu\nu}$. As in the Thirring model, from which this model is abstracted, the physical content of the theory turns out to be trivial. The results are nevertheless of interest (a) because they allow one to readily understand why the Thirring model is solvable and why it has trivial physical consequences and (b) because they provide an example of a case where the requirement of a positive energy spectrum places important, and explicit, constraints on a theory written in terms of currents. It is emphasized that although the present model was abstracted from the Thirring model it is not maintained that the resulting theory, or its solution as given here, is the same as the Thirring model, if by this term one means the conventional field-theoretical model. (auth)

15847 SPECIAL RELATIVITY. Shadowitz, A. Studies in Physics and Chemistry. Number 6. Philadelphia, W. B. Saunders Company, 1968. 215p.

A geometrical approach based on the Loedel Diagram is used to describe fundamental concepts of kinematics, and an analytic extension of the Loedel Diagram from two-dimensional to four-dimensional space–time is used which is formally identical with an analytic Minkowski treatment. Special attention is given to the interval, proper and nonproper observers, the twin paradox, conduction currents, defects of other geometric approaches, and the distinction between contravariant and covariant vectors. (J.F.P.)

Gravitation and General Relativity

Refer also to abstract 15696.

15848 VIERBEIN FIELD THEORY OF GRAVITATION. Kaempffer, F. A. (Univ. of British Columbia, Vancouver). Phys. Rev., 165: 1420-3(Jan. 25, 1968).

The sixteen components of the vierbein field which factorize the metric tensor are used to construct a simple nonlinear field theory of gravitation which, although it is shown to be equivalent to Einstein's theory physically, is based on a scalar action function of first order, replacing the Riemann scalar which serves as a second-order action function in the conventional approach. (auth)

15849 MOMENTUM FLUX BY GRAVITATIONAL WAVES. Cooperstock, Fred I. (Dublin Inst. for Advanced Studies). Phys. Rev., 165: 1424-6(Jan. 25, 1968).

It is demonstrated that two spinning rods constitute a simple source of gravitational wave momentum. The flux is proportional to c^{-5}, the same factor which appears in the wave energy loss. This is larger than the momentum loss calculated by other researchers for different sources by a factor of c. (auth)

Scattering Theory

Refer also to abstract 15694.

15850 (JINR–E2-3655) SOME CONSEQUENCES OF ANALYTICITY AND UNITARITY. Logunov, A. A.; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 17p. Dep.

Results concerning the asymptotic behavior of the cross sections of elastic and inelastic processes are presented. They were reported previously. For the sake of simplicity all particles are assumed to be spinless. (auth)

15851 ANALYSIS OF THE SOLUTION TO A PROBLEM IN SCATTERING THEORY FOR A NON-SELF-ADJOINT SCHROEDINGER EQUATION. Gasymov, M. G. (Moscow State Univ.). Dokl. Akad. Nauk Azerb. SSR, 22: 9-12(Oct. 1966). (In Russian).

The completeness of solutions to a problem in scattering theory is considered for the case of a nonself-adjoint Schroedinger equation defined in an entire space. The equation $-(\partial^2u/\partial x_1^2 + \partial^2u/\partial x_2^2 + \partial^2u/\partial x_3^2) + q(x_1,x_2,x_3)u = \lambda^2u$, (1) is considered with the assumption that the complex-valued function $q(x_1,x_2,x_3) = q(x)$ is defined in the entire space E_3 and satisfies the inequality $|q(x)| \leq Ce^{-\epsilon r}$. C and ϵ are constant positive numbers, $r = (x_1^2 + x_2^2 + x_3^2)$. Letting ω equal a unit vector in E_3 it is shown that the solution of the equation is a solution of the problem in scattering theory for equation (1). (auth)

15852 NEW APPROACH TO SCATTERING THEORY. Blankenbecler, R. (Princeton Univ., N. J.). pp 35-42 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

Upper and lower bounds for the phase shifts and the K-matrix elements of complicated problems are developed. A problem is considered solved if it can be written in such a form that it can be easily integrated on the computer. Single-channel scattering is discussed in order to introduce the type of manipulations to be used in more complicated problems. Then the multichannel (or multiparticle case) is thoroughly considered in order to get upper and lower bounds on the elements of the K-matrix. Finally, a few remarks are made about the application of these methods to the relativistic case. (J.F.P.)

15853 A MODEL OF A UNITARY S-MATRIX FOR PERIPHERAL INTERACTIONS. Dietz, K. (CERN, Geneva). pp 59-67 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

Particle scattering at 2 to 5 GeV is considered. The discussion includes the many-channel problem and quasi-two-body final states such as $K^+ + p \rightarrow K^* + N$, $K + N^*$, and $K^* + N^*$. Nonrelativistic quantum mechanics, the Born approximation, and the K-matrix are used. (J.F.P.)

15854 COMMENTS ON SUM RULES. Landsberg, P. T.; Morgan, D. J. (University Coll., Cardiff, Wales). pp 113-20 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123–Vol.4).

A method of obtaining sum rules for any system given the Hamiltonian of the system and the main variables to occur in the rules is presented. An exposition of a previous detailed account is given. Some well-known results of quantum mechanics are reviewed and shown to result from a unifying theory. The use of the theory to obtain new results is briefly indicated. (J.F.P.)

15855 REGGE-TRAJECTORY SLOPES. Mickens, R. E. (Vanderbilt Univ., Nashville). Nuovo Cim. (10), 53A: 1049-51 (Feb. 21, 1968).

It was recently shown (R. C. Hwa, Phys. Rev., 162: 1706(1967)) that using the four-particle unitarity equation and some technical assumptions "... all Regge trajectories share some universal properties in their slopes if it is required that scattering amplitudes have no essential singularities at nonsense, wrong-signature

values of the angular momentum. . . ." It is shown that this result can be obtained without assuming the validity of any four-particle unitarity equation. (L.B.S.)

15856 RELATIVIST PROBLEM OF THE MULTI-POLAR MOMENTS. Gherman, O.; Steinbrecher, Gh. Stud. Univ. Babes-Bolyai, Ser. Math.-Phys., 12: 93-7(1967). (In Rumanian).

Using the Lagrange's formalism, it is shown that Maxwell's equations for a field generated by a material medium in movement may be written in which $M_{ij}^{p_1 \cdots p_k}$ depend on the properties of the medium. The analyticity properties of Laplace transforms of these magnitudes are also studied using the dispersion relations. (auth)

15857 RENORMALIZATION GROUP IN DISPERSION THEORY. Granovskii, Ya. I.; Pantyushin, A. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 48-50(Mar.-Apr. 1967). (In Russian).

The possibility of introducing a renormalization group in field theory is usually associated with the presence of a logical gap in the Lagrangian of the interaction due to the possibility of finite renormalizations of a number of basic Green functions. The equation of a single-parameter group is written in dimensionless form. On refraining from a Lagrangian formulation of the theory, one is unable to isolate the grouping properties from the form of the counterterms, but these properties are retained in the theory and are associated with the exponent of the growth in amplitude. An equation is obtained for the renormalization group that follows from the invariance of the dispersion relations with respect to shifts in the point of subtraction. If subtraction is not required in the dispersion relation, the corresponding amplitude does not possess group properties. This approach to a renormalization group is more satisfactory than the Lagrangian method. (TTT)

15858 PERTURBATION THEORY AND UNITARITY. Granovskii, Ya. I.; Starikov, V. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 24-8(Mar.-Apr. 1967). (In Russian).

Perturbation theory for an S-matrix is a well-developed calculation method in quantum field theory, but it suffers from the disadvantage that unitarity is violated. Analysis also shows that perturbation theory violates unitarity for a wide class of operators V(t) due to the fact that unitarity conditions are nonlinear with respect to the coupling constant in the general case. The only case where unitarity conditions are not violated is the case of symmetrical boundary conditions. Starting from the Schroedinger equation in integral form with boundary conditions, the rules of writing the matrix elements for a V-matrix are formulated in detail. (TTT)

15859 ON THE HIGH-ENERGY BEHAVIOUR OF THE n-PARTICLE PRODUCTION CROSS-SECTION IN A MULTI-REGGE MODEL. Kajantie, K. (CERN, Geneva). Nuovo Cim. (10), 53A: 424-32(Jan. 21, 1968).

The behavior for $s \to \infty$ of the production cross section $\sigma_n(s)$ for n particles is investigated in a multiperipheral Regge model with special attention given to the three-particle case. Difficulties arising from the exchange of Pomeranchuk trajectories are pointed out. (auth)

15860 RESONANCE BEHAVIOR AND THRESHOLD CONDITIONS. Dilley, J. (Ohio Univ., Athens). Nuovo Cim. (10), 53A: 465-86(Jan. 21, 1968).

A soluble model where the left-hand cut of the partial-wave scattering amplitude is replaced by poles is used to discuss various aspects of resonance phenomena, and in particular, the role played by imposition of the threshold requirements. It is shown that the threshold conditions imply restrictions on the dynamic poles, and that these restrictions play an important role in constructing a physically reasonable scattering amplitude. A general result is derived concerning the relation of resonance widths and the threshold requirements. In addition, the relation of phase shifts rising through $\pi/2$ and resonance is discussed; in particular, it is shown that for s-waves (but not for higher partial waves) it is possible to have the phase shifts rise through $\pi/2$ without having a peak in the cross section. An example is given of the exceptional threshold behavior associated with a zero-energy bound state, $A(v) \to v^{l-1}$. (auth)

15861 KINEMATIC SINGULARITIES AND MACDOWELL SYMMETRY. Davies, W. E. A. (Queen Mary Coll., London). Nuovo Cim. (10), 53A: 828-32(Feb. 1, 1968).

A method for finding the kinematic singularities of parity-conserving helicity amplitudes by finding the singularities of the Trueman and Wick crossing matrix was previously given. A modified form of this result is found which is MacDowell symmetric. The result reduces to the well-known one for meson (π)–nucleon elastic scattering, and is in agreement with u-channel baryon exchange for $0^- + \frac{1}{2} \to 0^- + \frac{1}{2}$ interactions as calculated from Feynman diagrams. (J.F.P.)

15862 ON "BOOST" MATRIX ELEMENTS. Bedford, D. (Australian National Univ., Canberra). Nuovo Cim. (10), 53A: 804-7(Feb. 1, 1968).

A recurrence relation for the wave function of a spin-s particle, spin projection m boosted to momentum p in the z direction is derived and solved for some special cases. Majorana representations, the case m = s, and the general case are considered. (J.F.P.)

15863 TIME-DEPENDENT FORMULATION OF THE SEMI-CLASSICAL APPROXIMATION IN COLLISION THEORY. Lebedeff, S. A. (New York Univ., New York). Contract AT(30-1)-1480. Phys. Rev., 165: 1399-1405(Jan. 25, 1968).

A semiclassical approximation is presented which uses the wave-packet formulation of collision theory. First an appropriate semiclassical approximation is derived by assuming that the wave packet is and remains narrow during the passage of the interaction region. After this, a process is derived to decompose a macroscopic wave packet into narrow wave packets. The wave function, after the collision, is obtained by summing up the contributions from all the narrow wave packets into which the macroscopic wave packet was decomposed. Finally, using this function, the S matrix and the scattering cross section are calculated. (auth)

15864 N/D SOLUTIONS WITHOUT SIMULTANEOUS EQUATIONS. Thomas, B. R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 165: 1568-9(Jan. 25, 1968).

A procedure is developed for treating N/D problems in the pole approximation which avoids the usual solution of simultaneous equations. The method exploits a particular continued-fraction form for the scattering amplitude which allows sequential, rather than simultaneous, fitting of the poles. This leads to a significant reduction in computer-time and memory-space requirements. (auth)

15865 APPROXIMATION METHOD FOR THREE-BODY COLLISIONS. Sloan, Ian H. (Univ. of New South Wales, Kensington). Phys. Rev., 165: 1587-94(Jan. 25, 1968).

A new approximation for the three-body collision problem is described, which allows practical calculation of elastic, inelastic, rearrangement, and breakup amplitudes. The approximation is derived from a novel form of the Lovelace–Faddeev equations in which all two-body bound states appear explicitly. It appears in practice as a simple modification of the impulse-pickup approximation, and is expected to considerably extend the useful energy range of that approximation. It is shown that unitarity is satisfied within a certain approximation, and that the submatrix of the S matrix that excludes the breakup channel satisfies a unitary constraint. The symmetry requirements for identical particles can be treated rigorously, and lead to a practical simplification of the method. Numerical calculations of bound-state scattering in an exactly soluble model show encouraging results. (auth)

15866 ANALYTICITY AND CAUSALITY. Screaton, G. R. (Univ. of Maryland, College Park. Oxford Univ.). Contract AFOSR 500-66. Phys. Rev., 165: 1610-14(Jan. 25, 1968).

The energy variable for the on-mass-shell S matrix has a lower bound, so that an application of the usual causality condition, to deduce analyticity, is not possible. The related problem of the linear system is investigated, and it is shown that a quite general causality condition implies analyticity. (auth)

15867 APPLICATION OF ANALYTICITY PROPERTIES TO THE NUMERICAL SOLUTION OF THE BETHE–SALPETER EQUATION. Haymaker, Richard W. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 165: 1790-1802(Jan. 25, 1968). (UCRL-17700).

A new method of calculating phase shifts from the Bethe-Salpeter equation is presented. The differential equation is solved below threshold by using a variational method, and then the scattering amplitude is continued to the physical-scattering region, using Padé approximants. The singularity structure of the Bethe-Salpeter partial-wave amplitude in its off-shell variables was studied to find the nearby singularities that could most strongly affect the continuation. (auth)

15868 SOLUTIONS OF THE BETHE–SALPETER AND N/D EQUATIONS. Vasavada, Kashyap V. (Goddard Space Flight Center, Greenbelt, Md. Univ. of Connecticut, Storrs). Phys. Rev., 165: 1830-4(Jan. 25, 1968).

Results of calculations for bound and scattering states in off-mass-shell and on-mass-shell formalisms are compared by considering the solutions of the Bethe-Salpeter equation in the ladder approximation, and those of the exact N/D equations. The case of two scalar equal-mass particles interacting via the exchange of a third scalar particle is examined. An approximation to the

Bethe-Salpeter equation is also proposed which in the simple case under consideration reduces to an approximate N/D solution. In general, the values of the coupling constants required to produce a given bound state are found to be larger for the approximate solution or exact N/D equations than for the Bethe-Salpeter equation. The discrepancy increases as the mass of the exchanged particle becomes smaller, giving a nearby singularity. In view of the large coupling constants obtained in the N/D equations, some remarks are made regarding the relevance of these results to the dynamics of strongly interacting particles. (auth)

15869 POLE APPROXIMATIONS IN THE N/D EQUATIONS. Sweig, Mitchel J. (Ohio State Univ., Columbus). Phys. Rev., 165: 1893-9(Jan. 25, 1968). (COO-1545-24).

The use of Padé approximants (which are essentially a prescription for constructing pole approximations) to make the kernels of the N/D integral equations separable is proposed. If certain conditions on the function being approximated are satisfied, it can be shown that the sequence of approximate solutions which one obtains will converge to the exact solution. The method is applied to the neutral pseudoscalar-pseudoscalar-scalar bootstrap, and the known result is easily reproduced. (auth)

Particle Accelerators

Refer also to abstracts 14634–14636, 14751, 14795, 15693, and 15955.

15870 (AERE-GP/R-2379) ALTERNATING GRADIENT ELECTROSTATIC BEAM DEFLECTOR. Harrison, E. R. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1957. 8p. Dep. CFSTI. UK.

Some properties of an electrostatic A.G. beam deflector are discussed. A design is considered briefly which might be suitable for an inflector for beam injection into a synchrotron. (auth)

15871 (BNL-12060) SUPERCONDUCTING FFAG ACCELERATORS. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). Dec. 21, 1967. 6p. Dep. CFSTI.

Some characteristics of the FFAG accelerators which pertain to the possible use of this type of accelerator for current research in high-energy physics are described. These characteristics are the large radial aperture, and multistage FFAG design possibilities. The parameters chosen for obtaining particle energies of 800-GeV with such a multistage FFAG accelerator are presented. The possible problems of the superconducting FFAG accelerator are discussed. Some handy formulas available for estimating the parameters of the FFAG are included in the appendix. (B.G.D.)

15872 (BNL-12143) ANALYSIS OF IRIS-LOADED DEFLECTORS IN THE SMALL-HOLE APPROXIMATION. Hahn, H. (Brookhaven National Lab., Upton, N. Y.). Jan. 5, 1968. 19p. Dep. CFSTI.

The $\pi/2$ alternating periodic iris-loaded cavity is shown to be an ideal deflector for superconducting rf beam separators. Calculation of the shunt impedance of the iris-loaded deflector is based on the loose-coupling model, i.e., the deflector is represented as a chain of TM_{110} cavities, neglecting the perturbations due to the coupling holes. The dispersion diagram is derived by treating the deflector as a transmission line which is periodically loaded by shunt inductances. (W.H.K.)

15873 (BNL-50057, pp 37-53) HIGH-ENERGY ACCELERATORS. (Brookhaven National Lab., Upton, N. Y.).

The present status and program of the BNL Accelerator Department is summarized. The major efforts are devoted to the operation, maintenance, and exploitation of the AGS, a conversion program to increase the intensity of the AGS, and continuous investigation of new ideas in accelerator design and use. (W.H.K.)

15874 (CERN-68-1) PASSIVE COMPENSATION OF LONGITUDINAL SPACE CHARGE EFFECTS IN CIRCULAR ACCELERATORS: THE HELICAL INSERT. Sessler, A. M.; Vaccaro, V. G. (European Organization for Nuclear Research, Geneva (Switzerland)). Jan. 15, 1968. 26p. Dep.

The longitudinal electric field associated with a particle beam having azimuthal variation in charge density and moving within a helix which is surrounded by an outer sheath of arbitrary electrical properties is investigated theoretically. It is shown that for density variations having a wavelength long compared to the helix radius, the magnitude and sign of the electric field may be set to any desired value by appropriate choice of the helix and sheath parameters. In particular, conditions on the parameter of an helical insert of short circumferential length are given, for which there is complete compensation of the longitudinal space charge forces at one particle energy. The insert consists of a highly conducting helix surrounded by a ferrite sheath. Such a device should permit acceleration of a large line density, through the phase transition of an alternating gradient accelerator, without a decrease in longitudinal phase space density. (auth)

15875 (DESY-67/39) SYNCHROTRONFREQUENZ UND STABILITAETSGRENZE IM ELEKTRONENSYNCHROTRON IN ABHAENGIGKEIT VON DER ZAHL DER BESCHLEUNIGUNGSEINHEITEN. (Synchrotron Frequency and Stability Limits in the Electron Synchrotron as a Function of the Number of Acceleration Units). Piwinski, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1967. 11p. (In German). Dep.

In very high energy electron synchrotrons or storage rings, the synchrotron frequency may well be of the same order as the revolution frequency. In such cases, a calculation of synchrotron frequency must take into account the subdivision into sections with acceleration and synchrotron radiation, respectively. Performing this calculation by solving for the eigen-frequency of the transfer matrix, a more correct value for the synchrotron frequency and also a limit for the stability of the synchrotron oscillation is obtained. (auth)

15876 (DESY-67/44) WASSERSTOFF-KONDENSATIONS-TARGET. (Hydrogen Condensation Target). Kessler, Godehardt (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Nov. 1967. 17p. (In German). Dep.

A hydrogen-deuterium target is described, which reduces the safety problems connected with the handling of liquid hydrogen targets, without the liquid hydrogen being given up as the main cryogenic fluid. (auth)

15877 (JINR-P9-3639) ISSLEDOVANIE RASPREDELENIYA POTENTSIALA V DVUMERNOI MODELI USKORYAYUSHCHEGO PROMEZHUTKA SINKHROTSIKLOTRONA PRI NALICHII PROSTRANSTVENNOGO ZARYADA. (Investigation of the Potential Distribution in the Two-Dimensional Model of a Synchrocyclotron Accelerating Gap in the Presence of the Spatial Charge). Safonov, A. N.; Shekhtmai, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 27p. (In Russian). Dep.

An electrical field of the two-dimensional model of a synchrocyclotron accelerating gap in the presence of the cylindrical and semicylindrical spatial charge is investigated. The measurements were taken by the induced current method by using the probe with the linear charge distribution. The value of the space charge densities is found out at which a complete ion source shielding from the dee accelerating field takes place. The obtained results can be applied for the estimation of the critical densities of the space charge in real configurations of an accelerating gap. (auth)

15878 (NP-17237) ETUDE THEORIQUE ET EXPERIMENTALE D'UN FAISCEAU DE PHOTONS DE RAYONNEMENT DE FREINAGE DURCI EN ENERGIE. (Theoretical and Experimental Study of Beam of Photons of Hard Bremsstrahlung Radiation). Bertin, Pierre-Yves (Clermont-Ferrand Univ. (France). Faculte des Sciences). [1966]. 109p. (In French). Dep. Thesis.

High-energy photon beams are studied. A method of γ spectrometry is defined for which the application permits verification of various hypotheses used in studying the beam. From this an experiment on the photoproduction of π^+ and π^0 mesons in hydrogen around threshold is considered. Electron bremsstrahlung phenomena, photon production from electron–positron pairs, and problems of multiple Coulomb scattering are considered. Various solutions are studied for a photon beam. Monoenergetic electron bremsstrahlung was selected for the experimental studies. The beam construction and the experimental techniques used are described. The processing applied to the raw data to eliminate multiple Coulomb scattering and bremsstrahlung effects is described. Calculations for the coherence of photon beam decay in the lithium hydride column is verified by comparison of the experimental spectrum with the result of photon spectra convolution and the differential cross section for the opening angle in photon production. (tr-auth)

15879 (RHEL/R-110) SOME CALIBRATION MEASUREMENTS ON THE PLA. Batchelor, K.; Dickson, J. M.; Norcliffe, S. (Rutherford High Energy Lab., Chilton (England)). Nov. 1967. 29p. Dep. CFSTI. UK 4s. 6d.

An account is given of a method of setting-up the injector voltage and the radio frequency fields and phases of a three tank 50 MeV proton linear accelerator (the P.L.A.). This calibration technique involves measurements of the beam current and beam energy as a function of the parameters of the machine. The mean energy of the beam was measured by a time-of-flight method and

by an energy monitor (based on the range-energy relation in aluminium). The energy spectrum was measured by time-of-flight (at 10 MeV and 30 MeV) and by magnetic analysis. The results are compared with the theory of axial motion of protons in a linear accelerator. It is shown that the best energy stability is achieved when the machine is adjusted to operate with an integral number of phase oscillations in tanks 2 and 3, and that these conditions of operation can be readily achieved by the calibration technique described. (auth)

15880 (UCID-15279) DESIGN OF THE ASTRON LINEAR ACCELERATOR. Beal, J. W. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 17, 1968. Contract W-7405-eng-48. 15p. Dep. CFSTI.

The design features of a linear induction electron accelerator are described. This accelerator is for use in experiments with the Astron experiment. The parameters of the accelerator are: beam energy 4.23 MeV, beam current 1000 amperes, beam pulse length 0.3 μsec. The design beam emittance is 10π mr-cm in both transverse dimensions and an energy spread of 2 percent full-width-half maximum. The accelerator consists of an increasing gradient gun with an output beam energy of 562 keV, followed by two constant gradient injector sections each adding 220 keV to the beam energy. The remainder of the accelerator is made up of seventeen identical accelerator sections each supplying 190 keV to the beam energy. Solenoidal focusing magnets are positioned with a particular magnetic field strength in order to provide phase-space matching between the various sections of the accelerator. Steering magnets are placed so as to compensate for the earth ambient magnetic field and possible stray fields. (auth)

15881 (UCRL-18016) AXIAL INJECTION STUDIES ON THE 88-INCH CYCLOTRON: "HOLE LENS." Luccio, Alfredo U. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 2, 1968. Contract W-7405-eng-48. 11p. Dep. CFSTI.

In order to improve the axial injection system of the 88-inch cyclotron at LRL, a study was undertaken on the motion of injected particles through the magnetic field in the cyclotron upper pole hole. The magnetic field through the hole was measured and the trajectories of protons and deuterons were calculated in this resulting strong magnetic hole lens. (B.G.D.)

15882 (UJV-1898) THE ACCELERATION OF $^{3}He^{++}$ IONS IN THE U-120 CYCLOTRON. Fukatko, T.; Hrda, A.; Karban, O.; Krivanek, M.; Kult, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1967. 8p. Dep.

By modification of magnetic field gradient in the cyclotron U-120 the conditions were established which allowed the acceleration of $^{3}H^{2+}$ ions. The estimated energy of external beam was (21.4 ± 0.15) MeV. Since the particles of energy about 32 MeV could not be extracted from the accelerating chamber of the cyclotron they were used for obtaining isotopes of Pt. (auth)

15883 (ANL-Trans-570) DEPOLARIZATION OF A POLARIZED PROTON BEAM IN A SYNCHROTRON. Froissart, Marcel; Stora, Raymond. Translated by Betty Guttman (Argonne National Lab., Ill.), from Nucl. Instrum. Methods, 7: 297-305(1960). 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An initially polarized proton beam, when injected in a synchro-cyclotron, may suffer substantial depolarization effects, in view of magnetic field inhomogeneities seen by individual particles within the beam. A semiquantitative study is made for the 3 GeV Saclay synchrotron. The combined effect of vertical betatron oscillations and passage through the straight sections fringing fields is critical. A certain resonance condition is fulfilled for two values of the energy within the acceleration cycle, which entails a large depolarization in the present case. On the other hand, perturbations due to magnetic inhomogeneities inside the quadrants and the accelerating cavity as well as effects due to synchrotron oscillations prove to be small. (auth)

15884 ELECTROSTATIC GENERATORS. Allen, W. D. (Rutherford High Energy Lab., Chilton, Eng.). pp 181-214 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A review of the rate of progress in electrostatic generators in the last fifteen years, and of their advantages and limitations as instruments for nuclear structure research is presented. A survey of single-ended and tandem machines in the 6 MV terminal range is included. Recent developments in ion sources and accelerating tubes are summarized. A survey is also made of various systems operating in the 20 MeV range. Plans for projects in the 30 to 40 MeV range are described. (auth)

15885 AVF CYCLOTRONS FOR NUCLEAR STRUCTURE RESEARCH. Allen, W. D. (Rutherford High Energy Lab., Chilton, Eng.). pp 215-36 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A brief introduction traces the development of the AVF cyclotron. A specific example of an existing machine, the Harwell Variable Energy Cyclotron, is described in some detail; some leading features of a recent Conference on AVF cyclotrons are reported, and the prospect of these machines for nuclear structure research surveyed. (auth)

15886 BEAM PULSING. Allen, W. D. (Rutherford High Energy Lab., Chilton, Eng.). pp 237-58 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A brief historical survey traces the development of pulsed beams from the early demonstration by Alvarez with the Berkeley Cyclotron to the development of the 3 MV pulsed electrostatic generator, now in extensive use. Some general considerations arising from beam pulsing are discussed, followed by a description of the application of these consideration to a 6 MV machine and to a tandem. A description of the system of swept target bunching proposed by Grodzins, Rose and Van de Graaff is presented. (auth)

15887 POLARIZED ION SOURCES. Allen, W. D. (Rutherford High Energy Lab., Chilton, Eng.). pp 259-72 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A brief résumé is given of the main sources in use today, under the following topics: polarized protons from scattering of primary beams; the production of polarized protons by ionization of polarized atoms of thermal energies; polarized negative ions; by electron attachment from beams of polarized deuterons and from metastable states of hydrogen atoms. (auth)

15888 CHARACTERISTICS OF TYPICAL ACCELERATORS. Blewett, M. Hildred (Argonne National Lab., Ill.). Annu. Rev. Nucl. Sci., 17: 427-68(1967).

The various types of particle accelerators are reviewed, and characteristics of typical accelerators are compared. Also, the development of storage-ring systems is discussed. (W.H.K.)

15889 SOURCES OF POLARIZED IONS. Haeberli, W. (Univ. of Wisconsin, Madison). Annu. Rev. Nucl. Sci., 17: 373-426(1967).

A short review of the most important methods used to prepare beams of polarized particles is presented. The atomic beam method and the method involving separation of hyperfine states are discussed. Also, acceleration of polarized beams is briefly reviewed. (W.H.K.)

15890 BEAM CENTERING IN A NEUTRON GENERATOR. Spell, W. H. (Belhaven Coll., Jackson, Miss.); Iddings, F. A. Anal. Chim. Acta, 40: 515-16(Mar. 1968).

In the course of experiments to determine the neutron density near the target of Cockcroft–Walton type accelerators used in activation analysis, it became apparent that the drift tube was not aligned in the manner necessary for the deuteron beam to strike the center of the target. To assist in the correction for beam centering, an extremely simple method, utilizing copper foil autoradiography from the (n,2n) reaction of ^{63}Cu was devised. (auth)

15891 BYPASS-STORAGE RING OPTION FOR NAL. Courant, E. D.; Jones, L. W.; Montague, B. W.; Rowe, E. M.; Sessler, A. M. (National Accelerator Lab., Oak Brook, Ill.). Nucl. Instrum. Methods, 60: 29-35(Feb. 1968).

A bypass-storage ring system is explored in the context of its addition to the NAL accelerator. It is shown that colliding beam center-of-mass energies of 140 to 280 GeV are feasible with this system. Superconducting magnets for the storage ring seem a natural development. Luminosities in the range of $10^{32}/cm^2 \cdot sec$ would be anticipated. The geometry of a bypass-storage ring system is studied, and four self-consistent options are considered. Of these, two wherein the bypass is on the outside of the main ring are preferred. On comparing with a totally separate intersecting storage ring system, it is noted that the cost and size of the bypass-storage ring option are quite modest relative to its gain in energy, and that consequently the threshold of interest in a separate, intersecting storage ring system is forced up to energies of the order of a TeV. (auth)

15892 ANALYSIS OF RESONANCE DEPOLARIZATION OF DIRAC PARTICLES IN STRONG FOCUSING HIGH ENERGY SYNCHROTRONS FOR ANY DIRECTION OF THE INITIAL POLARIZATION. Ernst, V. (Univ., Munich). Nucl. Instrum. Methods, 60: 52-60(Feb. 1968).

The theory of Froissart and Stora of resonance depolarization of Dirac particles in circular accelerators is extended to any direc-

tion of the beam polarization at injection, and a sensitive dependence on the latter direction is found. If the particles are forced to perform the same number of revolutions during the acceleration process, acceleration of horizontally polarized particles is feasible and in comparison with vertical polarization it has the advantage of a better conservation of the degree of polarization. (auth)

15893 RADIATIVE EFFECTS ON THE MOTION OF ELECTRONS IN HOMOGENEOUS MAGNETIC FIELDS AND WEAK ELECTROSTATIC FIELDS. Zhukovskii, V. Ch.; Korovin, Yu. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 3, 65-72(May-June 1967). (In Russian).

The influence of radiations on the trajectory of relativistic electrons in constant and homogeneous magnetic fields and weak electrostatic fields was studied, and both quantum and classical methods were used to find the trajectory variations. (tr-auth)

15894 TRANSFORMER TYPE ACCELERATORS. Abramyan, E. A. (Inst. of Nuclear Physics, Novosibirisk, USSR). Nucl. Instrum. Methods, 59: 22-8(Feb. 1968).

The MeV direct transformer type accelerators are reviewed. Units generating electron beams of mean power of tens of kW and machines with pulse power of 10^8-10^9 W and frequency of several tens of cps are described. The efficiency of the first type accelerators is 90-95%, that of the second type is up to 80-90%. Type designs and strong-focussing accelerating tubes are concerned. The main parameters of several accelerators are given. Possibilities of increasing the highest energies of such devices, intensive proton beams acceleration and other problems are discussed. (auth)

15895 EFFECT OF THICK TARGETS ON SOME NUCLEAR REACTIONS COMMONLY USED TO MONITOR HIGH ENERGY PROTON BEAMS. Stehney, A. F.; Steinberg, E. P. (Argonne Natibnal Lab., Ill.). Nucl. Instrum. Methods, 59: 102-8(Feb. 1968).

Metal foils in contact with thick targets were used to study the effects of secondary particles on monitor reactions for high-energy protons. Quantitative data are presented for the nuclear reactions $^{197}Au(p,15p34n)^{149}Tb$, $^{27}Al(p,3pn)^{24}Na$, $^{27}Al(p,3p3n)^{22}Na$, and $^{27}Al(p,5p5n)^{18}F$. The results were applied in monitoring intensities of protons incident on thick targets in external and internal proton beams of a synchrotron. A technique for monitoring circulating beam intensities is suggested. (auth)

15896 HORIZONTAL CRYOSTAT OF CONTINUOUS FLOW TYPE FOR POLARIZED PROTON TARGETS. Masaike, A.; Sugimoto, S.; Yoshida, K. (Nagoya Univ., Japan). Nucl. Instrum. Methods, 59: 170-2(Feb. 1968).

A horizontal cryostat for polarized proton targets was constructed. In this cryostat, a continuous flow of liquid helium was sprayed onto the target cavity and cooled down the cavity to 1.2-1.5°K. (auth)

15897 QUADRUPOLAR HELICOIDAL PULSED DEVICE FOR PARTICLE FOCUSING. Salardi, G. (Istituto di Electronica, Pisa, Italy); Zanazzi, E.; Uccelli, F. Nucl. Instrum. Methods, 59: 152-6(Feb. 1968).

A pulsed quadrupolar helicoidal lens for focussing charged particles, whose advantages are a very high acceptance and much shorter source-image distance than those provided by the conventional optical systems composed of quadrupolar right lenses, with the same gradient and solid angle was studied theoretically and experimentally. A lens was constructed without iron poles, following the ideas of Panowsky and Septier using instead a pulsed magnetic field. This solution enables us to obtain a simpler design and higher gradient in the H field. Moreover the power supply is strongly reduced as compared with that required for statical lenses. (auth)

15898 HIGH-SPEED ROTATING VACUUM SEAL. Booth, R. (Univ. of California, Livermore). Nucl. Instrum. Methods, 59: 131-5(Feb. 1968). (UCRL-70661).

A high-speed, rotating vacuum seal was developed that has a relatively long life and a low leak rate, and is oil-free and easy to maintain. The seal has a 2.5" dia. opening and an operating speed of 1100 rpm. Typical seal life has been 1000 h between replacement of sealing parts. (auth)

15899 FULLY AUTOMATED ELECTROLYTIC TANK SYSTEM AND ITS USE IN CYCLOTRON INJECTION STUDIES. Reiser, M.; Mullendore, J. (Univ. of Maryland, College Park). Contract AT(40-1)-3342. Nucl. Instrum. Methods, 59: 93-101 (Feb. 1968).

A fully automated electrolytic tank analog system was built at the University of Maryland. This facility was used in central-region design studies for the University's sector-focused cyclotron, which is now under construction, and for similar studies by several other cyclotron laboratories. Main features of the facility are motor-controlled x,y positioning slides and a preset indexer system for automated probe motion, a self-balancing bridge and digital voltmeter measuring the potential at incremental steps, and a teletypewriter recording the data values. The electric potential distribution is measured in a scaled tank mockup of the electrode geometry at the cyclotron center and carried as a two-dimensional grid of data points. Grid size and incremental step width are adjustable within wide limits. The tank box with electrolyte (distilled water in this case) and electrode system is a separate unit mounted on an alignment table and can easily be replaced by other mockup structures. The recorded data, punched on paper tape, are used for calculations with the digital computer. A program called HOUNDOG permits the calculation and plotting (with a Calcomp unit) of equipotential lines. Ion trajectories are calculated and plotted with the PINWHEEL program. Magnetic field information for PINWHEEL was obtained from model magnet measurements or from theoretically determined field shapes. Some typical results of the central-orbit studies for the Maryland cyclotron are presented. (auth)

15900 ELEKTROFIZICHESKAYA APPARATURA. SBORNIK STATEI. VYPUSK 4. (Electrophysical Apparatuses. Collection of Articles. Issue 4). Komar, E. G. (ed.). Moscow, Atomizdat, 1966. 184p.

Separate abstracts were prepared for nine of the seventeen articles presented. The remaining eight articles were not within the scope of NSA. (B.G.D.)

For abstracts of individual papers see: 14615 and 15901-15908.

15901 CHARACTERISTICS OF THE ION BEAM PRODUCED BY THE INJECTOR OF A LINEAR ACCELERATOR. Ivanov, N. F.; Sivkov, Yu. P.; Solnyshkov, A. I. pp 3-22 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The structure of a beam of ions with an energy of 500-700 keV obtained at the output of the proton synchrocyclotron preinjector was investigated. The beam is designed for injection into a linear accelerator and for this reason the density distribution of ions over the phase space is the most important characteristic of the beam. Essentially, it determines the value of the current which can be captured by the linear accelerator. The transverse phase volume and the magnitude of the current were determined at a distance of approximately 1 meter from the output end of the focusing arrangement used in the linear accelerator. A proton source of the duoplasmatron type and the injector optics make it possible to obtain the crossover of the beam at this point when the maximum current is 500 ma, thereby providing for the optimum operation of the focusing arrangement. The requirements imposed on the phase volume of the beam injector are studied analytically. In the experimental part of the work, the phase volume was measured by means of equipment similar to that described by Collins and Stroud (1964). The only difference in the measurement technique was that the beam was recorded on photographic film and the photometry of the film image made it possible to establish the density distribution in phase space. The theoretical basis for the method used to process the measurement result is discussed. Two-dimensional and four-dimensional phase volumes occupied by a beam with density n, greater than some assigned value, and the portion of the total beam current contained in this phase volume are computed. Graphs are presented showing the distribution of beam density, maximum values of image edge projection coordinates, projection of four-dimensional phase volume, variation in the beam current, distribution of beam density and distribution of ion density. (ATD)

15902 PARTICLE GROUPING UPON INJECTION INTO A CIRCULAR ACCELERATOR OPERATING AT CONSTANT FREQUENCY. Sivkov, Yu. P. pp 23-9 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A grouping variation in which particles are injected into the separatriss right from the beginning of injection, but the shape of which changes in accordance with change in accelerator operating condition is reviewed. Characteristics of phase motion when f = constant and the grouping when f = constant are analyzed. The parameters characterizing the grouping for the condition f = constant for the proton accelerator ITEF at 7 GeV are cited by way of an example. (ATD)

15903 NONLINEAR RESONANCES Nn/3 AND Nn/4 IN THE REGULAR FIELD OF AN ISOCHRONOUS CYCLOTRON. Belov, V. P. pp 38-51 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

A study is made of the Nn/3 and Nn/4 resonances in the general form suitable for cyclotrons with arbitrary N. Note is made of the fact that reference works cited on the subject fail to consider $k^{(n)}$ (the average field index) completely, or do not consider all $k^{(n)}$, despite the fact that in certain cases this must be done. The equation for radial betatron oscillations is developed at length, and the Nn/3 and Nn/4 resonances are discussed mathematically. (ATD)

15904 NONLINEAR RESONANCES OF THE COUPLING $\nu_r - 2\nu_z = \epsilon$, $2\nu_r \pm 2\nu_z = N + \epsilon$ IN A CYCLOTRON WITH SPATIAL VARIATION OF MAGNETIC FIELD. Belov, V. P. pp 52–76 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.) Moscow, Atomizdat, 1966. (In Russian).

Coupled motion in the near-resonance region $\nu_r - 2\nu_z = \epsilon$ and $2\nu_r \pm 2\nu_z = N$, with all summands in the equations for betatron oscillations taken into consideration, is reviewed using asymptotic methods. In a unidimensional approximation the formulas for limiting amplitude, increment, and resonance band width coincide with the results obtained by Laslett and Sessler (Rev. Sci. Instr., 32, No. 11, 1235(1961)). (ATD)

15905 STATIC CHARACTERISTICS OF THE SLOT DEVICE. Popov, V. N. pp 77-83 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The static characteristics of a slot device, consisting of two conducting plates which form the slot, which is used as the sensor in systems for stabilizing the energy in a charged particle beam in direct current accelerators, are calculated on the basis of the following assumptions: the charged particle beam leaving the analyzer is of elliptical cross section; the cross section of the beam is oriented relative to the slot (one of the axes of the elliptical cross section is parallel to the slot); the width of the plates making up the slot device is much larger than the beam's cross sectional dimension (always so in practice); there is no emission of charged particles from the plates; and distribution of current density in the beam along the axes of the elliptical cross section is Gaussian. The results of the calculations suggest the need for compromise between the desirable slot transmission coefficient and permissible beam losses on the plates, and note is made of the fact that improving the focusing of the ion beam can improve the slot transmission coefficient while keeping losses at the same level as before. (ATD)

15906 QUESTIONS CONCERNING CALCULATIONS FOR MAGNETIC QUADRUPOLE LENSES. ASSEMBLY ACCURACY REQUIREMENTS. Doinikov, N. I. pp 84-98 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Magnetic quadrupole lenses are widely used in physics experiments and have become an indispensable part of the equipment in the modern physics laboratory. Because the transverse dimensions of the focused beam should be no greater than 2 to 3 mm in many cases, the tolerances in field nonlinearity are becoming more rigid, the requirements imposed on identity of magnetic characteristics more rigorous, and, as a result, so too are the requirements imposed on manufacturing quality. The general case of why the magnetic field of a real quadrupole lens is not strictly linear is elucidated, and it is pointed out that despite a good deal of writing on the subject of quadrupole lenses, little attention has been given to nonlinearity tolerances in lens fields, to justification for the accuracy required in their manufacture, or to a determination of the permissible deviations in the finished product from design parameters. The direct relationship between certain of the factors cited and the geometric parameters characterizing accuracy of assembly and manufacture of the pole pieces are discussed in detail, and an evaluation of accuracy required in the final stage of lens assembly work is made. (ATD)

15907 CONTROLLING THE MAGNETIC FIELD DERIVATIVE DURING INJECTION INTO A SYNCHROTRON. Belyak, A. Ya.; Gusev, O. A.; Nechaev, A. G.; Rezchikova, N. S. pp 123-35 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The physical basis for controlling the magnetic field derivative, the method for controlling this derivative, the variation in this derivative as a function of circuit parameters, the selection of circuit parameters, and the methods of stabilizing the derivative are established and verified experimentally by means of a model. The model consisted of a charging network, a discharging network and a system for stabilizing the voltage of the storage capacitor. The model was tested both in the stationary and transient state. The results of the experiment showed that in order to obtain a discharge current pulse with an amplitude of 210 A, the maximum for the model, the storage capacitor must be charged to a voltage of 2500 V while the voltage of the charging transformer reaches a value of 220 V. A stable operation of the system was obtained by varying the damping resistance in the range from 40 to 400 ohms when the model was powered by line voltage. Oscillograms of the transient process show that after the circuit is turned on, a steady state is established after 7–8 periods. The stabilization system becomes active during the 6th period. The results of the investigation showed that the equations derived and used to compute the circuit parameters of the model are valid. (ATD)

15908 TECHNOLOGICAL FEATURES IN STEP-BY-STEP PRODUCTION OF IRIS WAVEGUIDE FOR TRAVELING-WAVE ELECTRON LINEAR ACCELERATORS. Arkhangel'skii, F. K.; Ginzburg, E. L.; Gustov, G. K.; Kosyakin, M. N.; Urodkov, V. M. pp 174–81 of Elektrofizicheskaya Apparatura. Sbornik Statei. Vypusk 4. Komar, E. G. (ed.). Moscow, Atomizdat, 1966. (In Russian).

The various steps in the production of the waveguide sections are outlined. These steps include the stamping of dies, annealing, mechanical treatment, electropolishing, and welding of sections. Several die configurations are illustrated. Operational experience with these waveguides is also discussed. (C.E.S.)

15909 VARIABLE ENERGY EXTRACTION FROM A NEGATIVE ION CYCLOTRON AND RELATED MEASUREMENTS. Paul, Arthur Carl. Los Angeles, Univ. of California, 1967. 204p.

Thesis.

A scheme has been developed at UCLA for the variable energy extraction of 25 to 48 MeV protons into a common external beam transport system. The extraction is accomplished by stripping negative hydrogen ions with a thin foil. The magnetic field is held constant while the radius and azimuth of the stripping foil are chosen so that the trajectories for any energy cross at a common point outside the cyclotron vacuum tank. A small combination magnet placed at this crossover point bends the trajectories into a common beam transport system. The first order ion optic matrix representing the fringing field of the cyclotron is calculated at five different energies. An ion optic calculation of the beam transport system is given for two different phase space vectors at the stripper. Comparison is made with the observed operating values. (Disser. Abstr.)

15910 HIGH OUTPUT DUOPLASMATRON-TYPE ION SOURCE. (to United States Atomic Energy Commission). British Patent 1,101,293. Jan. 31, 1968. Priority date July 28, 1965, United States.

A duoplasmatron ion source for producing well defined and stable ion beams of increased output and quality is described. (W.H.K.)

15911 ELECTRON ACCELERATOR WITH SPECIFIC DEFLECTING MAGNET STRUCTURE AND X-RAY TARGET. Avery, Robert T. (to Varian Associates). U. S. Patent 3,360,647. Sept. 14, 1964.

Design of an apparatus for directing ionizing radiation on a portion of an object is described. It is composed of a linear accelerator for accelerating a particle beam along a substantially horizontal axis, a target positioned on said horizontal axis for producing ionizing radiation in response to said beam impinging thereon, means for deflecting the particle beam away from the axis, means for deflecting and focusing the particles of the beam at approximately the same point on said target from a direction substantially 90° with respect to the axis for producing ionizing radiation emanating from said target on said axis in a direction substantially 90° with respect to said axis. (U.S. Pat. Gazette)

15912 ACCELERATOARE DE PARTICULE INCARCATE. (Charged Particle Accelerators). Teodorescu, I. E. Bucharest, Editura Academiei Republicii Socialiste Romania, 1967. 408p.

The physical principles of charged-particle acceleration and the design features of the various types of accelerators are presented. Topics discussed are charged particle beam forming (focusing and transport), charged particle sources, direct acceleration, induction acceleration, resonant cyclic acceleration of relativistic and nonrelativistic particles, and resonant linear acceleration. Some problems associated with the operation and application of accelerators are described. (B.G.D.)

15913 EXPERIMENTAL VERIFICATION OF SELF-FOCUSING IN INTENSE, RELATIVISTIC, ELECTRON BEAMS. Roberts, Thomas George. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 176p.

Thesis.

A self-constricted high current beam of relativistic electrons is produced and its behavior as it propagates through an ionized medium is studied experimentally. A 30 nanosecond, 30,000-

ampere pulse of 3.5 MeV electrons was extracted from the electrode space of a pulsed x-ray machine. This beam of relativistic electrons was projected into an ionized medium formed by a conventional linear pinch in argon. This ionized medium has an ion density of the order of 10^{17} per cubic centimeter when the linear pinch has a minimum diameter. The beam of relativistic electrons was allowed to traverse the ionized medium for distances of 9, 18, 24, and 36 inches before being stopped by a target which was one of the electrodes of the linear pinch apparatus. The target material (brass) was such that the damage produced by the relativistic electron beam makes it difficult to determine the actual beam diameter, but this damage does indicate that the total energy of the relativistic electron beam was delivered at the above distances in a manner which is free of any instability that is capable of destroying the beam. Two attempts were made before the self-constricted high current beam of relativistic electrons could be produced in a reproducible manner. Therefore, the first linear pinch apparatus, the ionized medium which it produces, and the effects which were produced when attempts were made to extract the relativistic electron beam from the flash x-ray machine, also the modified linear pinch apparatus, the ionized medium which it produces, and the effects which were produced when the relativistic electron beam was extracted from the flash x-ray machine are described. (Disser. Abstr.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 14525, 15708, 15712, and 16000.

15914 (ANL-7305) ANL-CANDID: A TWO-DIMENSIONAL, DIFFUSION-THEORY CODE BASED ON CANDID2D. Leaf, G. K.; Kennedy, A. S.; Jensen, G. C. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 202p. Dep. CFSTI.

ANL-CANDID is an extension and modification of the two-dimensional diffusion-theory code CANDID2D developed by Computer Applications Incorporated (CAI) for use on the CDC 3600 computer. The code, as delivered, was capable of performing a reactivity calculation as well as geometry, composition, and buckling searches. These calculations were limited to rz geometry. In addition, the code could perform an up-scattering calculation. The present code is the result of extending and modifying the CAI code. The extensions include the capability of performing calculations in xy and $r\theta$ geometry, including the full periodic case. Adjoint and source calculations were added with an acceleration procedure for the source calculation. In addition, an α calculation was added. The use of two-term Chebyshev extrapolation was retained; however, the strategy for employing it was changed. In addition, the strategy employed in the search procedure was completely changed. Mesh refinement and restart capability have been provided. (auth)

15915 (CONF-661216-3) UTILISATION DES CONDUITS DE NEUTRONS. (Use of Neutron Collimators). (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1966]. 15p. (In French).

From Conference on the Study of Structures by the Use of Neutrons, Moscow, USSR.

The transmission properties of glass, Cu, Ni, and ^{58}Ni as neutron collimators are calculated. The technical problems to be solved in the design of a neutron collimator are briefly outlined. Preliminary tests made in the design of a neutron collimator are described. (J.S.R.)

15916 (GA-7543) GAKIN: A ONE DIMENSIONAL MULTIGROUP KINETICS CODE. Hansen, K. F.; Johnson, S. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 24, 1967. Contract AT(04-3)-167. 123p. Dep. CFSTI.

The computer program GAKIN is described as it existed on August 24, 1967. The multigroup equations are given, and the numerical algorithm is described together with some of the techniques used in the solutions. A sample problem is included as is a listing of the program. (D.C.W.)

15917 (GA-8188) GAMBLE-5: A PROGRAM FOR THE SOLUTION OF THE MULTIGROUP NEUTRON-DIFFUSION EQUATIONS IN TWO DIMENSIONS, WITH ARBITRARY GROUP SCATTERING, FOR THE UNIVAC-1108 COMPUTER. Dorsey, J. P.; Froehlich, R. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 4, 1967. Contract AT(04-3)-167. 78p. Dep. CFSTI.

The computer program GAMBLE-5 finds, over a nonuniform rectangular mesh imposed upon a rectangular area of either the x-y or the v-z plane, a discrete numerical solution to the multigroup, time-independent neutron diffusion equations for a heterogeneous reactor. The program can handle an arbitrary group scattering matrix and fission transfer from each group into any other group. The numerical methods used in the FORTRAN IV code are described, together with input preparations, edits, and operating instructions. (D.C.W.)

15918 (GA-8345) SINGLE DIFFERENTIAL CROSS SECTION OF ZIRCONIUM HYDRIDE. Carriveau, Gary Walter (Gulf General Atomic, Inc., San Diego, Calif.). June 1967. Contract AT(04-3)-167. 108p. Dep. CFSTI.

Thesis. Submitted to San Diego State Coll., Calif.

The single differential scattering cross section of zirconium hydride was measured at 296 and 700°K to complement room-temperature measurements previously made. These measurements were needed to compare with theoretical predictions from the broadened Einstein level and acoustical mode model at a temperature more consistent with reactor operating temperatures. The main problem in taking measurements at the elevated temperatures has been to prevent contamination and hydrogen loss in the sample. A specially constructed sample holder and oven was used. A neutron transmission measurement was made before and after heating to determine the change in sample composition. The measurements were performed at 700°K over an angular range of 20 to 155° and at 296°K from 80 to 155°. A pulsed source of neutrons was produced using an electron linear accelerator. The energy of the neutrons used ranged from 0.008 to 1.0 eV and was measured using the time-of-flight method. Several correction methods were used in the analysis of the data including a correction for multiple scattering in the sample. The results show that the multiple scattering correction method is valid at this sample thickness. The correction methods are discussed. The experimental results, when compared to the prediction of the theoretical model, compare very well at both temperatures. The results show that the single differential cross section of zirconium hydride is temperature dependent. It can be concluded that the broadened Einstein level and acoustical mode model best describes the thermalization of neutrons in zirconium hydride for a wide range of temperatures. (auth)

15919 (INP-568/PS) INVESTIGATION OF MAGNONS IN HEXAGONAL COBALT. Krasnicki, S.; Wanic, A.; Dimitrijevic, Z.; Todorovic, J. (Institute of Nuclear Physics, Krakow (Poland)). 1967. 5p. Dep.

Inelastic magnon scattering of neutrons (λ = 1.124 Å) on a single crystal of hexagonal cobalt was investigated by the neutron diffraction technique. The dispersion relation for the acoustic magnon branch, up to the energy 0.035 eV, in the [001] direction of propagation was obtained. The results are compared with the theoretical model of G.G.E.Low. (auth)

15920 (JAERI-1146) FREDAM-BI: A FORTRAN-IV PROGRAM FOR THE COMPUTATION OF THE FREQUENCY DISTRIBUTIONS OF BERYLLIUM AND ICE BY ROOT SAMPLING METHOD. Nakahara, Y.; Kato, O. (Japan Atomic Energy Research Inst., Tokyo). Oct. 1967. 24p. Dep.

A program that was developed to evaluate the frequency distributions of beryllium and ice by root sampling method is described. Prior to the computation of the frequency distribution, the eigenvalue problem of the secular determinant is solved by the modified Jacobi method. For the secular determinant, the formulas given by Nakahara in the case of beryllium and by Forslind in the case of ice are used. Dispersion relations, polarization vectors and the generalized frequency distributions can also be calculated with this program. The program is written in FORTRAN IV and can be used on both the IBM 7044 and IBM 7090. (auth)

15921 (JUL-CONF-1(Suppl.)) DISKUSSIONSTAGUNG UEBER NEUTRONENPHYSIK AN FORSCHUNGSREAKTOREN. VOM 25.-28. APRIL 1967 IN DER KERNFORSCHUNGSANLAGE JUELICH. Vortragskurzfassungen. (Discussion Meeting on Neutron Physics of Research Reactors, April 25-28, 1967 at Juelich Nuclear Research Center. Summaries of Contributions). (Kernforschungsanlage, Juelich (West Germany)). May 1967. 35p. (In German). Dep.

Three contributions presented at the discussion meeting at the Juelich Nuclear Research Center are compiled. These are studies of crystal structure in a high-flux reactor, low-energy nuclear fission, and new results of crystal structure research with neutrons. Separate abstracts were written for the three individual papers. (J.S.R.)

For abstracts of individual papers see: 15922, 15923, and 16057.

15922 (JUL-CONF-1(Suppl.), Paper 1) ETUDES DE STRUCTURES AU REACTEUR A HAUT FLUX. (Study of Crystal Structure in a High Flux Reactor). Bertaut, E. F. (Centre National de la Recherche Scientifique, Grenoble (France)). 4p. (In French).

The crystal structure studies that would be possible in a high flux reactor (such as study of the very complex structure of a protein, the length of a crystal bond, and magnetic structures) are briefly outlined. (J.S.R.)

15923 (JUL-CONF-1(Suppl.), Paper 3) NEUERE ERGEBNISSE DER KRISTALLSTRUKTURFORSCHUNG MIT NEUTRONEN. (New Results of Crystal Structure Research with Neutrons). Dachs, H. 13p. (In German).

A bibliographic review is given of data obtained in the last five years from crystal structure research with neutrons. Results obtained on structures of compounds containing hydrogen are summarized. The use of neutron diffraction for the determination of improved Debye-Waller factors, low temperature studies, phase structures, and chemical bonds are indicated. The formation of holes in alloys can be investigated by neutron diffraction. The use of neutron diffraction in the study of the structure of glasses, melts, and liquids is also indicated. (J.S.R.)

15924 (KR-122) NEUTRON SCATTERING FROM MAGNETITE BELOW 119°K. Samuelsen, E. J.; Bleeker, E. J.; Dobrzynski, L.; Riste, T. (Institutt for Atomenergi, Kjeller (Norway)). Oct. 1967. 24p. Dep.

A neutron scattering experiment to look for spin-wave excitation energy changes of magnetite at the transition point 119°K showed no such change. During this work it was discovered, however, that the low-temperature structure gives rise to weak extra neutron diffraction lines that can be indexed as $(h,k,l + \frac{1}{2})$ in cubic indices. From the observed neutron polarization sensitivity of the intensities and the increasing structure factors with increasing $\sin\theta/\lambda$, it is concluded that the extra reflections are not directly due to magnetic ordering (ferrimagnetic spirals or $Fe^{2+}-Fe^{3+}$ ordering on the octahedral sites). Rather they are caused by a lowering of the crystal symmetry. (auth)

15925 (ORNL-TM-1736) PROMPT NEUTRON DECAY AND REACTIVITY MEASUREMENTS IN SUBCRITICAL URANIUM METAL CYLINDERS. Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 35p. Dep. CFSTI.

Prompt neutron decay constants have been determined for unreflected and unmoderated subcritical cylinders of enriched uranium (93.15% ^{235}U) by the Rossi-α technique. The cylinder diameters were 17.77, 27.94, and 38.09 cm and the heights, at these diameters, varied from 10.184 to 2.548, 8.431 to 5.399, and 7.502 to 4.780 cm, respectively. The decay constants agreed to within 4% with those measured by the pulsed neutron method; the comparison with the results of S_n transport theory calculations showed disagreements as large as 20%. Reactivities as much as 33 dollars subcritical were determined from the prompt neutron decay constant at delayed criticality and changes in the prompt neutron lifetime with cylinder height calculated by S_n transport theory. These reactivities agreed favorably with values determined by an analog computer whose input was the response of an ionization chamber to power changes when an assembly was disassembled from delayed criticality to a given reactivity. (auth)

15926 (TIM-847) THE TDC CODE. Fader, W. J.; Rodgers, R. J.; Mynatt, F. R.; Lawrence R. E. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Sept. 15, 1964. Contract AT(30-1)-2789. 115p. Dep. CFSTI.

A comprehensive description is given of the TDC code, which solves the Boltzmann equation or the adjoint equation in finite cylindrical geometry by the discrete S_n method. The problem may be homogeneous or inhomogeneous, but all sources must be isotropic. Neutron scattering must also be isotropic. The computer program is written in FLOCO II for the IBM 7090. (D.C.W.)

15927 (UCRL-50323) MODELS FOR CALCULATING EFFECTS OF THERMAL MODERATOR MOTION. Canfield, Eugene (California Univ., Livermore. Lawrence Radiation Lab.). July 15, 1967. 23p. Dep. CFSTI.

Formulas are derived for the Doppler-broadened effective cross sections for arbitrary forms of the cold nuclear cross section for two models (a Maxwell gas, and a single-speed model where each atom has energy $\frac{1}{2}$ kT). For some simple smooth cross sections, the model results are in excellent agreement for energies and temperatures typical of reactor calculations and even up to regions appropriate to nuclear explosions and stellar interiors, but diverge for very subthermal neutrons. The area under a resonance is found to be temperature-dependent (contrary to common belief). Again the models are in good agreement at ordinary temperatures, but the agreement is only qualitative at very high temperatures. The problem of choosing a target-atom velocity (before collision) for Monte Carlo calculations of the subsequent kinematics is discussed. A formal method of choosing the velocity is shown, but it appears impractically slow and tedious for Monte Carlo calculations. (auth)

15928 EIGEN DISTRIBUTIONS IN SLOWING DOWN THEORY. Cadilhac, M. (Univ., Marseille); Gilewicz, J. J. Nucl. Energy, 21: 907-9(Dec. 1967).

The use of a continuous energy variable in place of a multigroup formulation is considered in eigen solutions of the slowing-down operator with absorption, $Af(E) + \lambda f(E) = 0$. The essential features of the problem are illustrated by treating a particular case. (UK)

15929 THERMALIZATION OF NEUTRONS IN CONDENSED MATTER. Beyster, J. R.; Young, James A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Annu. Rev. Nucl. Sci., 17: 97-128(1967). (GA-7952).

A survey of the understanding of neutron thermalization is presented with emphasis on the calculation of neutron cross sections for moderators and on the measurement of thermal neutron scattering and spectra. A brief discussion of each of several different moderators is included. 50 references. (D.C.W.)

15930 INELASTIC NEUTRON SCATTERING AND DYNAMICS IN SOLIDS AND LIQUIDS. Sjolander, Alf (Chalmers Tekniska Hogskola, Goteborg). pp 121-30 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

The discussion of inelastic neutron scattering includes the technique, theory, and results on phonons in solids, and liquid dynamic results. It is apparent from the discussion that the neutron inelastic scattering technique is superior to that of x-ray scattering. (J.F.P.)

15931 QUANTUM STATISTICS AND SLOW NEUTRON SCATTERING BY GASES. Plummer, J. P. (City Univ. of New York, Flushing); Summerfield, G. C.; Zweifel, P. F. J. Chem. Phys., 47: 4923-30(Dec. 15, 1967).

A surprisingly simple expression in "closed form" for the cross section $d^2\sigma/d\Omega d\epsilon$ for the scattering of thermal neutrons (including polarized neutrons) from an ideal quantum gas is derived. This result extends the work of Van Hove on the quantum gas. An expansion is obtained for $d\sigma/d\epsilon$. The case of elastic scattering is treated separately. From these expressions is obtained a criterion for ignoring the statistics of the scatterer in favor of classical (Boltzmann) statistics. This criterion should have some validity for weakly interacting systems. It is shown that the effects of statistics on the neutron cross section for a helium-4 gas range from 5% or less for the noninteracting gas up to as much as 40% for the interacting system. (auth)

15932 NEUTRON SPECTRA IN THIN POLYETHYLENE SLABS. Armstrong, S. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-eng-52. Nucl. Sci. Eng., 31: 153-5(Jan. 1968). (KAPL-P-3306).

Thermal neutron spectra were measured inside thin polyethylene slabs and the experimental results were compared with calculations made using relatively simple transport theory. Fair agreement was obtained for spectra in slabs as thin as 0.5 in. The effects of the epithermal spatial source distribution on the calculated spectra are also discussed. (S.F.L.)

15933 EFFECT OF EMPTY CHANNELS ON THE NEUTRON MODERATION LENGTH. Grigor'ev, I. S. At. Energ. (USSR), 23: 352-4(Oct. 1967). (In Russian).

Neutron age in water was measured in a prism 126 × 126 × 126 cm. The lattices were formed by two sets of thin-walled Al tubes with radii equal to 1.2 and 2.15 cm. The neutron source was a multiplying unit of natural uranium rods having a diameter of 22 mm, which is placed in the thermal column of a reactor. Epithermal neutron flux was measured on a cadmium-covered fission chamber. The neutron age was measured in directions parallel and perpendicular to the axis of the channels. The relative increase in neutron age in the medium with the empty channels is compared to the neutron age for water without channels. The absolute value of the neutron age, which was measured as the difference between the squares of the migration and diffusion lengths, turned out to be equal to 62 ± 5 cm^2. The difference between the experimental and calculated values was within the experimental error. (TTT)

15934 EXPERIMENTAL DETERMINATION OF THE OPTIMAL GEOMETRY OF A THERMAL NEUTRON FLUX STANDARD. Andreev, O. L.; Yaritsyna, I. A. At. Energ. (USSR), 23: 348-50(Oct. 1967). (In Russian).

A plexiglass cube 690 mm on edge containing an inner graphite cube whose dimensions could be varied was used to moderate the fast neutrons from six Pu-Be neutron sources. A small boron counter having an operating volume of 2 cm^3 was used to count the thermal neutron flux in an air cavity in the center of the cube. The counter was covered with cadmium in order to investigate the quality of the neutron flux. The relative flux was determined at various distances from the neutron sources to the air cavity. On decreasing the graphite thickness, the thermal neutron flux increased, and attained a maximum in pure plexiglass containing no graphite. The quality of the neutron flux improved in all cases on moving the neutron sources from the graphite into the plexiglass. In the absence of graphite the thermal neutron flux maximum corresponded to a position of the neutron sources at a depth of 33 mm from the edge of the air cavity, that is, at a distance close to the thermal neutron diffusion length in plexiglass. In the presence of graphite the maximum is shifted to a distance of 23 mm. The graphite causes a certain increase in neutron intensity. The graphite should be omitted to obtain a maximum

thermal neutron flux per unit of fast neutrons from the neutron sources. (TTT)

15935 ACCURACY OF TRANSPORT THEORY CALCULATIONS OF AN ANISOTROPIC NEUTRON FLUX. Jauho, Pekka; Kalli, Heikki (Technical Univ. of Helsinki). Nucl. Sci. Eng., 31: 318-24(Feb. 1968).

The discrete S_2, S_4, and S_8 approximations for a monoenergetic half-space problem with a delta-function of neutrons as a source are given; the values of four suitable integral quantities are compared with the results of Monte Carlo calculations. The errors in the space-dependent integrated neutron flux are shown in several figures. Also, tests with different mesh resolutions of the iteration net and with different standard quadrature sets have been made. (auth)

15936 POSSIBILITY OF SAVING TIME IN COMPUTATION OF SCATTERING SPECTRA. Steinhoff, G. (VEB Kombinat Kernenergetik, Berlin). Kernenergie, 10: 258-9(Aug. 1967). (In German).

A method is given for the determination of cos ψ and sin ψ which permits a significant reduction in the time required to calculate scattering spectra. A computer program that incorporates the method has been developed. (J.S.R.)

15937 STUDIES ON THE OPTICS OF NEUTRONS. V. ON THE POLARIZATION AND DEPOLARIZATION OF NEUTRONS IN PARTIALLY SATURATED FERROMAGNETS. Halpern, Otto (American Express Co., London). Acta Phys. Austr., 25: 363-6(Dec. 1967).

A comparison was made of the presentation given in Fermi's book on Nuclear Physics with that contained in some older papers of ours. It is particularly pointed out that the (schematic) analysis of Fermi only treats completely unrealistic cases that can never be observed. (auth)

15938 STABILITY ANALYSIS OF NON-LINEAR SPACE DEPENDENT REACTOR KINETICS. Kastenberg, William Edward. Berkeley, Univ. of California, 1966. 112p.

Thesis.

The spatial and temporal behavior of neutron distributions governed by the non-linear diffusion equation approximation to neutron transport theory is considered. Stability criteria for the equilibrium states of various reactor feedback models are determined by the method of comparison functions. The results are stated in the form of theorems. These comparison functions are used to construct simple solutions, with error bounds, to the equations considered. The basic tool in the analysis is a corollary to the Westphal-Prodi theorem for parabolic partial differential equations which is proved. Comparison functions are constructed and are shown to bound the true solutions by means of the corollary. The corollary enables one to choose comparison functions which satisfy the initial and/or boundary data if necessary, a property not permitted in the original theorem. The three reactor models considered are the prompt feedback, Newton's law of cooling, and the adiabatic models. For the Newton's law of cooling and prompt feedback models, the stability of the equilibrium state is governed by the generalized buckling κ_0^2, and its relationship to μ_0^2, the lowest eigenvalue of the associated linear Helmholtz equation. For the prompt feedback model the zero equilibrium state is asymptotically stable when $\kappa_0^2 \leq \mu_0^2$ if the flux is perturbed initially by changes in κ_0^2 and for distributions of neutrons introduced into a reactor, originally at the zero state. When $\kappa_0^2 > \mu_0^2$, the positive solution, $\phi_0(x)$, of the corresponding steady state equation is asymptotically stable. This holds for initial perturbations about the steady state, for changes in κ_0^2 and for the introduction of neutrons into a reactor originally at the zero state. For the Newton's law of cooling model, the zero equilibrium state is asymptotically stable when $\kappa_0^2 \leq \mu_0^2$ and when the initial temperature distribution is greater than zero in the reactor. The initial perturbations in the flux are the same as for those in the corresponding prompt feedback case. When $\kappa_0^2 > \mu_0^2$, the positive solution, $\phi_0(x)$, of the steady state equation is asymptotically stable when only the initial flux is perturbed in the same way as the corresponding prompt feedback case. Perturbations in the initial temperature distribution can only be considered when the temperature is decreased from its equilibrium value. For the adiabatic model, the zero equilibrium state is asymptotically stable for all values of the generalized buckling κ_0^2, when the initial temperature distribution is greater than zero in the reactor. This holds for transients caused by coolant channel failures and when neutrons are introduced into a reactor with no energy removal mechanism which is originally at the zero state. Since the comparison functions bound the true solution from above and below for all space and time in the reactor, a bound on the maximum value of the excursion is obtained with little effort. One can specify a bound on the maximum value of the neutron flux that can be tolerated in the reactor and determine the bound on the initial condition needed to provide that this maximum is not exceeded. Conversely, the bound on the initial condition can be specified and the bound on the maximum value of the excursion can be determined. Simple approximate solutions are obtained by choosing comparison functions so that they are as close together as possible. Since the true solution lies between these comparison functions, one can determine the errors of the approximations involved. As shown by two examples, relatively close bounds can be achieved with simple comparison functions. (Disser. Abstr.)

15939 ARC DISCHARGE ATOMIC PARTICLE SOURCE FOR THE PRODUCTION OF NEUTRONS. Pollock, Herbert C. (to General Electric Co.). U. S. Patent 3,359,422. Oct. 28, 1954.

A device is described which consists of a number of closely spaced electrodes to provide electric discharge gaps which produce arc discharges instantaneously upon the application of a potential difference. The electrodes include a hydrogen composition to provide atomic particles for the production of neutrons when the electric arc occurs. (S.F.L.)

15940 ATOMIC PARTICLE SOURCE. Pollock, Herbert Chermside. British Patent 1,101,921. Feb. 7, 1968. Filed Feb. 20, 1961.

An apparatus for producing pulsed neutrons by bombarding a target with ions of hydrogen isotopes is described. The system consists of a cylindrical dielectric member with a multiplicity of metal electrodes containing hydrogen isotopes positioned on the outer circumference. The electrodes are pulsed to produce electric arcs between the electrodes, thus releasing ions of the hydrogen isotopes. These ions are accelerated toward a target containing hydrogen isotope ions and react with the target releasing neutrons. (W.H.K.)

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Refer also to abstracts 14756, 15411, 15984, 16013, 16052, and 16091.

15941 SEMI-RELATIVISTIC CALCULATION OF THE DEUTERON ELECTRODISINTEGRATION AT THE QUASI-ELASTIC PEAK. Kocevar, P. (Univ. of Graz). Z. Phys., 209: 457-69(1968).

The cross section for inelastic electron–deuteron scattering at the quasielastic peak is calculated in the laboratory system using completely relativistic kinematics. The difference between the exact cross-section formula and Durand's simple sum-rule expression is found to be approximately 1.2% for 4-momentum transfers of 2.5 to $4f^{-1}$ and the influence of the deuteron wave function on the final to be smaller than 1% for reasonable deuteron models. Final-state corrections are introduced through a simple correction term in the cross-section formula. (auth)

15942 THE NEUTRON–NEUTRON SCATTERING LENGTH FROM REACTIONS WITH TRITIUM TARGETS. Fuschini, E.; Maroni, C.; Massa, I.; Uguzzoni, A.; Vannini, G.; Verondini, E.; Vitale, A. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nucl. Phys., A109: 465-70(1968).

The $^3H(n,d)2n$ reaction was studied at 15.1 MeV neutron energy. The deuteron energy spectrum at 0° is well reproduced by using the Watson approximation with $\alpha_{n-n} = -17$ fm. A satisfactory agreement was found among the α_{n-n} values derived, by the same procedure, from all but one published work with tritium targets and two neutrons in the final state. (auth)

15943 A SEARCH FOR EXCITED STATES IN ^{3}He BY THE $^3He(p, p')^3He^*$ REACTION. Harbison, S. A. (Univ. of London); Kingston, F. G.; Johnston, A. R.; McClatchie, E. A. Nucl. Phys., A108: 478-80(1968).

No evidence was found for the excitation of states of ^{3}He through the reaction $^3He(p,p')^3He^*$ with 30 MeV protons. (auth)

15944 DIFFERENTIAL CROSS SECTION AND POLARIZATION IN p-α SCATTERING FROM 22 TO 25 MeV. Darriulat, P.; Garreta, D.; Tarrats, A.; Testoni, J. (CEN, Saclay, France). Nucl. Phys., A108: 316-24(1968).

The proton differential cross section and polarization in p-α scattering were measured at 12 lab scattering angles from 20° to 155° for proton energies between 22 and 25 MeV. The resonance corresponding to a $\frac{3}{2}^+$ state of ^{5}Li is clearly observed. An energy-dependent phase-shift analysis of most of the avail-

able p-α scattering data between 20 and 27.8 MeV was made. The energy dependence of the phase shifts was expressed in terms of the resonance parameters with the Breit–Wigner single-level formula for the resonant part, and it was assumed to be linear for the non-resonant part. The resonance is well reproduced for both cross section and polarization. (auth)

15945 POLARIZATION OF NEUTRONS FROM THE $^{2}H(d,n)^{3}He$ REACTION BELOW 400 keV. Behof, A. F.; May, T. H.; McGarry, W. I. (Naval Research Lab., Washington, D. C.). Nucl. Phys., A108: 250-6(1968).

The polarization of neutrons produced in the $^{2}H(d,n)^{3}He$ reaction was measured at deuteron bombarding energies between 60 and 380 keV in 20-keV intervals. Except for an angular distribution of polarization at 340 keV, all measurements were performed at a neutron emission angle of 47° in the lab system. The deuterium target was a thick layer of heavy ice. A helium polarimeter was employed for these measurements. The results of the present experiment indicate that the polarization does not vary rapidly in the energy range investigated. (auth)

15946 PROTON–DEUTERON ELASTIC SCATTERING CROSS SECTION AT 17.1-MeV CENTER-OF-MASS ENERGY. Bixby, G. E.; Smythe, Rodman (Univ. of Colorado, Boulder). Phys. Rev., 166: 946-8(Feb. 20, 1968). (COO-535-567).

The absolute differential elastic scattering cross section of deuterium for 25.7-MeV protons was measured for laboratory scattering angles from 15 to 165°. A solid-state lithium-drifted silicon detector was used with a 1024-channel pulse-height analyzer to identify the scattered protons and recoil deuterons. A sealed deuterium gas target with thin windows was used. The data were corrected for nuclear reactions in the detector. The absolute accuracy of the cross-section measurement is estimated to be 4%. (auth)

15947 TEMPERATURE AND PRESSURE EFFECTS ON THE OPTICAL POLARIZATION OF ^{3}He NUCLEAR SPIN. Bley, P.; Turowski, P. (Univ., Karlsruhe, Ger.). Z. Angew. Phys., 24: 57-60(Jan. 3, 1968). (In German).

By NMR measurements with optically polarized ^{3}He it is shown that the pumping time is the same at 77°K and room temperature. However, the decay time of the nuclear polarization in the rf discharge at 77°K is longer by a factor of 1.8 compared to its value at room temperature. The variation of the degree of polarization with gas density is qualitatively the same for both temperatures, but the value of polarization at 77°K is higher by a factor of 1.2. This increase in polarization corresponds to the measured temperature dependence of pumping and decay times. When the rf discharge is turned off, the nuclear polarization of the ^{3}He-Gas in the Pyrex glass bulbs used in this investigation decays at 77°K with a time constant of approximately 20 hr. From the observed decrease of this decay time with increasing temperature the activation energy is estimated to 0,4 kcal/Mol. (auth)

15948 POLARIZATION OF DEUTERONS SCATTERED FROM ^{4}He. Trier, Alex. Madison, Wis., Univ. of Wisconsin, 1966. 152p.

Thesis.

The polarization parameters iT_{11}, T_{20}, and T_{22} of deuterons elastically scattered from ^{4}He were measured at bombarding energies between 3 and 11 MeV and laboratory scattering angles of 45°, 60°, and 75°. The polarized deuteron beam from the Wisconsin Tandem accelerator was used in the measurements. The vector polarization iT_{11} had not previously been measured. The tensor parameters T_{20} and T_{22} had been measured with a different method for energies up to 9 MeV. Broad peaks were observed for T_{20} and T_{22} at all three angles for iT_{11} at 45° and 75°. Values as large as −0.50 at 4 MeV and +0.39 at 8 MeV were observed for iT_{11} at 45°. Values as large as +0.56 for T_{20} and +0.77 for T_{22} were observed at 6 MeV and 60°. Above 7 MeV the polarization parameters change slowly with bombarding energy. The uncertainty in iT_{11} was about 0.01. For several energies at 60° and 45° there is poor agreement between the present measurements of T_{20} and T_{22} and those of McIntyre. A phase shift analysis of $^{4}He(d,d)^{4}He$ using differential cross section data and polarization data from the present experiment was carried out. The results were compared to similar results obtained by McIntyre and Haeberli using their measurements of T_{20}, T_{21}, and T_{22}. S-, P-, and D-waves were included in these analyses. The phase shifts obtained in the present work agree qualitatively with the earlier analysis, but give a better representation of the T_{20} and T_{22} data above 8 MeV and of the iT_{11} data generally. The differences between the two sets of phase shifts are most pronounced for the P-waves, where they are as large as 20°. The values calculated for the total reaction cross section from either of the two sets of phase shifts are not in agreement with experimental data at 10 MeV. It appears that F-waves must be included in the analysis in order to fit the reaction cross section. (Disser. Abstr.)

15949 NEUTRONS FROM DEUTERON BOMBARDMENT OF ^{3}He AND ^{7}Li. Kerr, Roderick George. Madison, Wis., Univ. of Wisconsin, 1967. 88p.

Thesis.

Neutron spectra produced when ^{3}He and ^{7}Li are bombarded with deuterons were investigated. Time-of-flight techniques were used to detect the neutrons. ^{3}He was bombarded with deuterons having energies from 7 to 12 MeV. Neutrons were observed at emission angles from 0 to 70°. The energy distribution of the neutrons was studied as a function of bombarding energy and emission angle. In addition a search was made for a possible state in ^{4}Li. The observed spectra exhibit no evidence for such a state, and an upper limit for the cross section for its formation is deduced. ^{7}Li was bombarded with deuterons having energies from 3 to 8 MeV. Observation angles ranged from zero to 160°. Neutrons leaving ^{8}Be in states at 16.63, 16.92, 17.64, 18.14, 18.93, 19.05, and 19.24 MeV excitation energy were observed. The angular distributions for the 16.63, 17.64, and 18.14 MeV levels are all strongly forward peaked, indicative of a stripping process. Plane wave Butler–Born approximation stripping theory was employed to fit the angular distributions for these three levels. The data for all three levels could be fitted reasonably well with $l = 1$ angular momentum transfer. Reduced widths as calculated from the plane wave theory have a definite dependence upon the bombarding energy. Ratios of these reduced widths appear to be fairly energy independent. The two states at 16.63 and 16.92 MeV excitation energy in ^{8}Be appear to have different character. The 16.63 state is strongly populated in the study and shows a strong stripping pattern. The 16.92 state is weakly populated and the cross section is inclined toward isotropy. This indicates that these two states may be single particle states, the 16.63 MeV state having a $^{7}Li + p$ configuration, and the 16.92 MeV state having a $^{7}Be + n$ configuration. The neutrons from deuteron breakup on ^{7}Li were also investigated and an upper limit for the cross section for this process was found. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

15950 (JINR-P4-3666) O MEKHANIZME POGLOSHCHENIYA π^{+}-MEZONOV LEGKIMI YADRAMI. (On the Mechanism of π^{+} Meson Absorption by Light Nuclei). Kopaleishvili, T. I.; Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. (In Russian). Dep.

The reaction $(\pi^{-}n)$ with stopped π^{+} mesons and the reaction $(\pi^{+}p)$ with moving π^{+} mesons on ^{12}C and ^{16}O nuclei are investigated within the one-particle absorbtion mechanism. It is shown that the probability (cross section) of these reactions is by two (one) orders smaller than the probability (cross section) of the corresponding two-nucleon reactions $(\pi^{-}NN)$ and $(\pi^{+}NN)$. (auth)

15951 (JINR-P4-3681) KLASTERNYE PRIVEDENNYE SHIRINY DLYA ^{14}N I ^{15}N. (Reduced Cluster Widths for ^{14}N and ^{15}N). Zhusupov, M. A.; Lkhagva, O.; Rotter, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 11p. (In Russian). Dep.

Reduced triton and α widths for the low-lying levels of ^{14}N and ^{15}N having the configurations $(lp)^{n-2}(2s,ld)^{n}$, and $(lp)^{n-1}(2s,ld)^{n}$, respectively, are calculated. These cluster widths are compared with those of lighter nuclei having the pure configuration $(lp)^{n}$. The mechanism of reactions of the type $(^{6}Li,d)$ on light nuclei at low energies is discussed. (auth)

15952 (JINR-P4-3684) ELEKTROMAGNITNYE PEREKHODY V YADRAKH ^{15}N I ^{15}O. (Electromagnetic Transitions in ^{15}N and ^{15}O Nuclei). Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 8p. (In Russian). Dep.

The probabilities of electromagnetic transitions in ^{15}N and ^{15}O nuclei are calculated within the shell model with intermediate coupling. (auth)

15953 (LA-3842) TOTAL REACTION CROSS SECTIONS FOR PROTONS BETWEEN 10 MeV AND 22 MeV ON ^{12}C AND ^{40}Ca. Dicello, John F. Jr. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 148p. Dep. CFSTI.

Thesis. Submitted to Texas Agricultural and Mechanical Univ., College Station.

Total reaction cross sections for protons on ^{40}Ca were mea-

sured at fifteen energies between 10.3 and 21.6 MeV by the beam-attenuation method. The differential elastic cross sections for protons on ^{40}Ca were obtained at fifteen energies between 9.8 and 21.7 MeV. These measurements were made at intervals of 3° between 12 and 30° and at intervals of 5° between 35 and 165° in the laboratory. Total reaction cross sections for protons on carbon were measured at ten energies between 9.8 and 19.5 MeV. The total reaction cross section for ^{40}Ca rises sharply at low energies, reaches a maximum value around 13 MeV, and reaches a minimum around 16 MeV. The rise at the lower energies is a result of the Coulomb barrier. The dip at 16 MeV is probably associated with the (p,n) threshold at 16 MeV. The present differential elastic cross sections and total reaction cross sections for ^{40}Ca are compared with predictions of the optical model. The total reaction cross sections for carbon show resonant-like structures in the neighborhood of 10.4 and 13.8 MeV. The structure observed in these total reaction cross sections is related to levels around 11.6 and 14.6 MeV in the compound nucleus ^{12}N. Because of the presence of these sharp resonances in the total reaction cross section, it does not seem reasonable to apply the optical model to ^{12}C at lower energies. (auth)

15954 (SAL-8) THE INTERACTION OF HIGH-ENERGY ELECTRONS WITH ^{6}Li AND ^{7}Li. Hutcheon, Ronald M. (Saskatchewan Univ., Saskatoon. Saskatchewan Accelerator Lab.). Nov. 1967. 162p. Dep.

The 140-MeV electron linear accelerator was used to measure the electron scattering and electrodisintegration cross sections of ^{6}Li and ^{7}Li. The inelastic electron scattering form factors were measured for the low-lying excited states of both isotopes, and in some cases there are large discrepancies between the present and previous results. Most of these were traced to the presence of a very large quasi-continuous cross section underlying the narrow levels of both ^{6}Li and ^{7}Li. Because of the improved resolution, in the present experiment the narrow peaks were resolved from the continuous background whereas, in previous cases, a large portion of the continuous cross section had been included in the area of the peaks. The present results have greatly simplified the interpretation of the low-excitation energy levels in both nuclei. The theoretical fits to the ^{6}Li elastic and inelastic form factors indicate that the data can not be fitted using a simple harmonic oscillator model with the same oscillator parameter for the s- and p-shells. However consistent results are obtained using an s-shell parameter of approximately 1.63 fm and a p-shell parameter of approximately 2.0 fm. In ^{6}Li the broad quasicontinuous cross section is peaked at approximately 4 MeV and has a width of about 2.5 MeV, while in ^{7}Li the peak in the cross section is at approximately 5 MeV and the width is much larger. An attempt was made to determine some of the properties of these broad levels which seem to be associated with the α-d and α-t decay of ^{6}Li and ^{7}Li, respectively. In ^{7}Li the reduced E2 transition probabilities of the 4.63- and 6.6-MeV states were measured; they tend to verify a rotational model for the first four states of ^{7}Li. The giant resonance regions of the lithium isotopes were studied at both low and high momentum transfers by inelastic electron scattering and by electrodisintegration. The data from the latter experiments is very difficult to interpret, but, although they yielded no new nuclear information an approximate test of the virtual photon formalism was provided. The present low momentum transfer inelastic electron scattering spectra taken in the giant resonance region are quite different from previous results and indicate a great deal of structure. The high momentum transfer data taken in the same region of excitation energy suggest that an α-d model may be applicable to ^{6}Li when the interaction wavelength is short enough. (auth)

15955 GAMMA RAY SPECTROSCOPY IN VAN DE GRAAFF RESEARCH. Alburger, David E. (Brookhaven National Lab., Upton, N. Y.). pp 299-320 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A review is presented of the techniques used by the Brookhaven Van de Graaff group in the study of gamma rays from the excited states of light nuclei. The topics include the determination of multipolarities with a magnetic pair spectrometer, studies of gamma rays from short-lived activities, gamma ray angular distributions and correlations, and various methods using lithium-drifted germanium detectors. The operating characteristics of the Brookhaven Van de Graaff accelerator are also described briefly. (auth)

15956 ENERGY LEVEL STRUCTURE OF ^{9}Be AND ^{9}B. Kroepfl, J. J.; Browne, C. P. (Univ. of Notre Dame, Ind.). Nucl. Phys., A108: 289-315(1968).

The mirror nuclei ^{9}Be and ^{9}B were investigated using various reactions. Using the ^{7}Li(^{3}He,p)^{9}Be reaction, excitation energies and (widths) of 2429.2 ± 1.7(<8) keV, 3076 ± 15 (289 ± 22) keV and 4704 ± 25(743 ± 55) keV were measured. Values of 2431.9 ± 7.0 keV and 3040 ± 15(294 ± 20) keV were found using the ^{9}Be (d,d')^{9}Be reaction. Using the ^{10}B(^{3}He,α)^{9}B reaction, excitation energies and (widths) of 2361 ± 5(81 ± 5) keV and 2788 ± 30(548 ± 40) keV were measured. Part of the spectrum from this reaction could be interpreted as a level in ^{9}B near 1.5 MeV with a width of about 0.7 MeV but the evidence is inconclusive. Upper limits are imposed on the intensity of any narrow levels in ^{9}Be between 3 and 6 MeV in excitation and in ^{9}B between 4 and 7 MeV in excitation. No indication was found that the 2.43 or 3.06 MeV states in ^{9}Be are composed of more than one level. The experimentally determined energy level structure of ^{9}Be is compared with theoretical predictions based on various nuclear models. In addition, a two-parameter analysis was made of the ^{10}B + ^{3}He → p + α + ^{8}Be(g.s.) reaction by observing with solid-state detectors the proton and alpha particle in coincidence. No evidence was found for an excited state in ^{9}B, between 3.5 and 9.5 MeV, which decays via a proton to the ground state of ^{8}Be; however, three excited states in ^{12}C at 9.6, 10.8, and 14.1 MeV were found to decay via an alpha particle to the ground state of ^{8}Be. (auth)

15957 STUDIES OF (d,d) AND (d,p) REACTIONS WITH CARBON ISOTOPES AT LOW BOMBARDING ENERGIES. Cottrell, R. L. A.; Lisle, J. C.; Newton, J. O. (The Univ., Manchester, Eng.). Nucl. Phys., A109: 288-304(1968).

The absolute cross sections for scattering of 4 to 6 MeV deuterons from ^{12}C and ^{13}C were measured. An optical-model analysis of these data was performed, and the results obtained applied to a DWBA analysis of ^{13}C(d,p)^{14}C data obtained in the present experiment and elsewhere. An attempt was also made to allow for a compound nucleus contribution to the cross section. (auth)

15958 ELASTIC SCATTERING OF DEUTERONS BY ^{9}Be AND ^{28}Si. Machali, F.; Saleh, Z. A.; Baranik, A. T.; Asfour, F.; Boun-douk, I.; Storizhko, V. E. (Atomic Energy Establishment, Cairo). Atomkernenergie, 13: 29-32(1968).

Differential cross sections for the elastic scattering of deuterons from ^{9}Be and ^{28}Si were measured in the E_d = 1.0 to 2.5 MeV region at five scattering angles. The ^{9}Be(d,d)^{9}Be cross sections are smooth over the entire energy range and show no clear resonance behavior. The excitation functions and angular distributions are in good agreement with the s-wave analysis. As expected the ^{28}Si(d,d)^{28}Si data show an appreciable deviation from Rutherford scattering with increasing energy. (auth)

15959 INELASTIC SCATTERING OF ELECTRONS FROM THE 19.4 MeV LEVEL IN ^{12}C. Beer, G. A.; Drake, T. E.; Hutcheon, R. M.; Stobie, V. W.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Nuovo Cim., (10) 53B: 7-10 (Jan. 11, 1968).

The momentum transfer dependence of the transition matrix element for the 19.4 MeV level in ^{12}C was measured in a previously uninvestigated region. The results, when compared with particle-hole calculations for this level, strongly support an assignment $J^{\pi} = 2^{-}$. (auth)

15960 SEARCH FOR A 5.5-MeV LEVEL IN ^{7}Li. Harvey, P. J. (Univ. of Melbourne). Aust. J. Phys., 21: 103-5(Feb. 1968).

An attempt was made to observe a predicted 5.5-MeV level in ^{7}Li using neutron inelastic scattering by ^{7}Li at 14 MeV. The spectrum of the scattered neutrons was measured using a time-of-flight spectrometer. Neutron groups corresponding to the ground state and the 0.48- and 4.63-MeV states were readily identified, but no evidence was obtained for the existence of any level with higher excitation energy. (D.C.W.)

15961 THE ^{10}B + d → α + α + α REACTION. Assimakopoulos, P. A.; Gangas, N. H. (Democritus Nuclear Research Center, Athens). Nucl. Phys., A108: 497-507(1968).

The reaction ^{10}B + d → α + α + α is studied at deuteron bombarding energy of 0.40 MeV with the ^{12}C compound nucleus formed at an excitation around the 25 MeV giant resonance. Two of the α-particles in the final state are detected in coincidence by two solid-state detectors. For the presentation of the experimental data, a new method has been employed. The reaction mechanism is found to be sequential two-body decay involving the 0^{+} ground state and the 2^{+}, 2.9 MeV first excited state of ^{8}Be. Contributions from simultaneous decay in three alphas or other energetically possible excited states of ^{8}Be up to 17 MeV are not present in the experimental results. The triple differential cross-section $d^{3}\sigma/dS d\Omega_1 d\Omega_2$ is measured. (auth)

15962 RESONANCES IN THE (n,p) REACTION ON ^{12}C. Rimmer, E. M.; Fisher, P. S. (Oxford Univ.). Nucl. Phys., A108: 567-76(1968).

An excitation function for the $^{12}C(n,p)^{12}B$ reaction was measured by detecting the beta decay of the ground state of the ^{12}B produced over a range of incident neutron energies from 14.5 to 22 MeV. The cross section exhibits a strong resonance with a peak cross section of 19 mb at an excitation energy of about 22 MeV in ^{13}C and another weaker resonance at 20.5 MeV excitation. (auth)

15963 RESONANCES IN THE (p,n) REACTION ON ^{12}C. Rimmer, E. M.; Fisher, P. S. (Oxford Univ.). Nucl. Phys., A108: 561-6(1968).

A measurement was performed of the variation of the integrated cross section for the $^{12}C(p,n)^{12}N$ reaction leading to the ground state of ^{12}N. The incident proton energy range covered was from the reaction threshold at 18.9 to 50 MeV. The cross section exhibits resonance structure reaching about 4 mb at excitation energies in ^{13}N of 21 and 24 MeV with a broader possible resonance around 27 MeV. (auth)

15964 RADIOCARBON PRODUCTION RATE NEAR SEA LEVEL. Gold, Raymond (Argonne National Lab., Ill.). Phys. Rev., 165: 1411-14(Jan. 25, 1968).

The natural production of radiocarbon by cosmic-ray neutrons was observed experimentally. Proportional counters, filled with 2 atm of nitrogen, were employed to detect the exoergic $^{14}N(n,p)^{14}C$ reaction. Electronic pulse-shape discrimination is utilized to discriminate against meson- and photon-induced events. A ^{14}C production rate of $(1.89 \pm 0.08) \times 10^{-7}$/sec/cm^3 was obtained for the air-land interface at the Argonne National Laboratory site. This result represents the average value for a time duration of one month, November–December, 1966. Fluctuations as large as 25% from this average value were observed. The density of slow neutrons can also be determined from this experimental result. An average value of $(1.19 \pm 0.06) \times 10^{-6}$ neutrons/cm^3 was found for the air-land interface at the Argonne National Laboratory site (53°N geomagnetic latitude). (auth)

15965 POLARIZED PROTON SCATTERING FROM OXYGEN AT 40.0, 37.1, 34.2, 30.4, 27.6, AND 24.2 MeV. Eldridge, Hudson Bluford. Los Angeles, Univ. of California, 1967. 115p. Thesis.

The polarized proton beam from the UCLA cyclotron was used to measure the angular dependence of the left-right scattering asymmetry for oxygen at the mean incident proton energies of 24.2, 27.6, 30.4, 34.2, 37.1, and 40.0 MeV. The different proton energies were obtained by varying both the thickness of the internal first scatterer (carbon) and the amount of aluminum degrader inserted in front of the second (ice) target. The second target consisted of a 0.032" thick by 1.25" diameter disk of ice bounded on the edges by a copper plate and on the faces by .00025" Mylar foil which was mounted inside an evacuated chamber in contact with a reservoir of liquid nitrogen. Four NaI(Tl) crystals 2" in diameter by ½" thick mounted on RCA 8053 phototubes were placed two on each side of the incident beam at equal angles relative to the beam so that protons scattered to the left and to the right at two different angles may be counted at the same time. Pulses from the photomultiplier tubes were shaped and amplified by conventional electronics, then routed into four 100-channel segments of a 400-channel pulse height analyzer. A solenoid magnet capable of rotating the plane of polarization ±180° was used allowing three independent measurements of the polarization to be made at each angle. The peaks in the scattered proton spectra arising from elastic scattering from oxygen and hydrogen and inelastic scattering from oxygen were resolved by seeking a minimum x^2 fit between the measured pulse height distribution and an assumed theoretical distribution. For the theoretical pulse height distribution, gaussian peaks were assumed for the groups scattered elastically from oxygen while the background function chosen depended upon both energy and scattering angle. The angular distributions of the asymmetry for each incident proton energy are presented along with the systematic and statistical errors. For the incident proton energies of 40.0, 37.1, 34.2, 30.4, and 27.6 MeV the usual diffraction-like pattern is evident where the maxima and minima in the asymmetry occur at smaller scattering angles as the bombarding proton energy increases. Also there is a rather smooth and systematic variation in the pattern as the incident proton energy is changed. A change in the shape of the asymmetry angular distribution occurs between 27.6 and 24.2 MeV bombarding energies as evidenced by the 24.2 MeV distribution. These general properties of the angular distribution of the left-right asymmetry are consistent with previous measurements at similar energies. (Disser. Abstr.)

15966 STUDY OF SOME OF THE THREE FINAL PARTICLE REACTIONS INDUCED BY ^6Li ON ^9Be. Jambunathan, Ramanathan. Minneapolis, Univ. of Minnesota, 1967. 72p. Thesis.

The reactions of 3.3 MeV ^6Li ions on ^9Be resulting in α-α-^7Li, α-α-$^{7*}Li$ (480 KeV), α-t-^8Be, and α-p-^{10}Be were studied to learn: the reaction mechanisms, that is, whether these reactions proceed through a direct break-up process or a sequential process or both; the existence of certain states in ^{11}Be with a (^9Be + d) structure formed by the easy absorption of the loosely bound deuteron from ^6Li; and whether a neutron transfer mechanism forming ^8Be and ^7Li plays any special part. The α-α-^7Li and α-α-$^{7*}Li$ reactions were studied using two solid state detectors to detect the α particles in coincidence. One detector was fixed at −30° (E_f detector) while the other was set at different angles (θ_m angles). From the events on the α-α loci, isometric projections, i.e., $E_f - I_f - \theta_m$ plots were obtained. From the analyses of these plots for both the reactions, it was concluded that the direct break-up process contributes at most 5%. The levels at ~10.2, 11.4, ~12.6 and 13.6 MeV in ^{11}B participate in these reactions, though the participation of other levels cannot be completely ruled out. No particular level is so pronounced to indicate that it may have a (^9Be + d) structure. The contribution from ^8Be g.s. break-up to the α-α-^7Li reaction is about 10%. The α-t-^8Be and α-p-^{10}Be reactions were studied using a particle identifying system coupled to the fixed detector. The α-t reaction goes mainly through a sequential process. While the α-p spectrum at $E_p(-30°) - E_\alpha(30°)$ could be satisfactorily explained by a direct break-up process, the $E_p(-30°) - E_\alpha(60°)$ spectrum seems to indicate the presence of a sequential process. The relative (extrapolated) cross sections for α-α, α-t, and α-p reactions are ~135 mb; ~30 mb; ~15 mb. (Disser. Abstr.)

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Refer also to abstracts 14433, 14827, 14831, 14832, 14836, 15411, 15659, 15688, 15895, 15953, 16011, 16013, 16017, 16052, 16054, and 16078.

15967 ANALOGUE STATES IN THE s-d SHELL. Endt, P. M. (Natuurkundig Laboratorium, Utrecht). pp 58-75 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

Strong analog-to-anti-analog M1 γ-ray transitions have been observed in many nuclei in the s-d shell. The $f_{\frac{1}{2}} \rightarrow f_{\frac{1}{2}}$ transitions in ^{27}Al, ^{31}P, ^{35}Cl, and ^{37}Cl are discussed at some length. Relative (p,γ) yield measurements are described in which many different chemical compounds are used. Measurements of γ-ray spectra at (p,γ) resonances are best performed with Ge(Li) counters. The peculiar difficulties of the energy calibration at high γ-ray energies are discussed. Some results are shown from the $^{26}Mg(p,\gamma)^{27}Al$ reaction. Measurements of proton elastic scattering can provide the resonance total widths and the proton orbital momenta. This is illustrated with results on the $^{26}Mg(p,p)$ and $^{30}Si(p,p)$ reactions in the E_p = 1 to 2 MeV region. Finally, an investigation is described of the $J^\pi = 2^-$, 3^-, 4^- and 5^- analog states in ^{38}Ar by means of the $^{37}Cl(p,\gamma)^{38}Ar$ and $^{37}Cl(p,\alpha)^{34}S$ reactions. Striking enhancements are found of $J \rightarrow J$ M1 transitions, as compared to $J \rightarrow J - 1$ or $J \rightarrow J + 1$. (auth)

15968 TIME-OF-FLIGHT TECHNIQUES AND INELASTIC SCATTERING OF NEUTRONS. Starfelt, N. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 138-59 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

The use of neutron time-of-flight techniques especially in the study of neutron inelastic scattering is described. Methods of analysing and describing neutron inelastic scattering data are reviewed. (auth)

15969 PROTON EXCITATIONS IN ^{49}V. Pullen, D. J. (Univ. of Pennsylvania, Philadelphia); Rosner, Baruch; Hansen, Ole. Phys. Rev., 166: 1142-6(Feb. 20, 1968).

The reaction $^{48}Ti(^3He,d)^{49}V$ was studied at around 17-MeV incident energy with an over-all resolution of 20 keV. Ninety-four levels were observed up to 8.7-MeV excitation, and the corresponding deuteron angular distributions were recorded in the angular interval 7.5° to 40°. Spectroscopic information was extracted for 26 of the stronger transitions by means of a distorted-wave analysis of the differential cross sections. The results are compared to nuclear-structure-model predictions. (auth)

15970 NUCLEAR-STRUCTURE STUDIES OF ^{86}Sr AND ^{89}Y BY INELASTIC ELECTRON SCATTERING. Peterson, G. A. (Yale Univ., New Haven); Alster, Jonas. Contract AT(30-1)-2726. Phys. Rev., 166: 1136-41(Feb. 20, 1968). (YALE-2726-507).

The nuclei ^{86}Sr and ^{89}Y were studied by observing the inelastic

scattering of 65- and 70-MeV electrons through angles 70 to 150°, with an over-all energy resolution of 200 keV. Strongly excited states were found in ^{88}Sr at 1.84 MeV (2^+), 2.74 MeV (3^-), 4.0, 6.5, and 7.8 MeV; and in ^{89}Y at 1.50 MeV ($\frac{3}{2}^-$), 1.73 MeV ($\frac{5}{2}^-$), 2.21 MeV ($\frac{5}{2}^+$), 2.52 MeV ($\frac{7}{2}^+$), 2.86 MeV ($\frac{5}{2}^-,\frac{7}{2}^+$), 3.1, 3.72, 4.0, and 4.16 MeV. The data were analyzed by a distorted-wave calculation to determine multipolarities and reduced nuclear radiative transition probabilities. The results show that the excited states in ^{89}Y cannot be described by a weak coupling of the $2p_{\frac{1}{2}}$ proton to core-excited states of ^{88}Sr. The sum of the B(E2)'s of the low-lying quadrupole states in ^{89}Y is found to be about 30% of the B(E2) of the 1.84-MeV state of ^{88}Sr, and three strong octupole states are excited in ^{89}Y, where only two are expected from the weak-coupling model. No detailed information on the single-particle structure of the levels could be obtained at these momentum transfers. (auth)

15971 NUCLEAR SPIN, HYPERFINE-STRUCTURE SEPARATION, AND NUCLEAR MAGNETIC MOMENT OF 18-MIN ^{88}Rb. Vanden Bout, Paul A.; Dymanus, Antoni; Ehlers, Vernon J.; Prior, Michael H.; Shugart, Howard A. (Univ. of Califronia, Berkeley). Contract W-7405-eng-48. Phys. Rev., 166: 1131-5 (Feb. 20, 1968). (UCRL-17680).

The atomic-beam magnetic-resonance technique was used to measure the nuclear spin and the hyperfine-structure separation of 18-min ^{88}Rb in the $^2S_{\frac{1}{2}}$ electronic ground state. These results, combined with the Fermi-Segrè formula, yield the nuclear magnetic moment. Results are: $I = 2$, $\Delta\nu = \pm 1186.084(18)$ MHz, $\mu_I(\text{uncorr}) = \pm 0.506(5)$ nm, $\mu_I(\text{corr}) = \pm 0.508(5)$ nm. Present nuclear theory favors assignment of the negative sign to the value of the moment. (auth)

15972 INELASTIC DEUTERON SCATTERING AND (d,p) REACTIONS FROM ISOTOPES OF Ti. V. Ti(d,d'). Wilhjelm, P. (Univ. of Copenhagen); Hansen, Ole; Comfort, J. R.; Bockelman, C. K.; Barnes, P. D.; Sperduto, A. Contract AT(30-1)-3223. Phys. Rev., 166: 1121-30(Feb. 20, 1968).

Results of elastic and inelastic deuteron scattering from ^{47,48,49,50}Ti are presented. Deuteron energies from 2.5 to 10 MeV were used, and (d,d') angular distributions were obtained at several energies in the ^{47,50}Ti cases. The elastic-scattering data are analyzed by means of the optical model, whereas the (d,d') data are analyzed in a simple direct-reaction picture employing collective-model-type form factors. The (d,d') data are in reasonable agreement with the direct-reaction predictions only at deuteron energies of 8 and 10 MeV. A reanalysis of the earlier Ti(d,p) results is presented. A deuteron potential in better agreement with the elastic-scattering data is used, resulting in an improved agreement with the (d,p) strength sum rules. (auth)

15973 STUDY OF FIRST-FORBIDDEN BETA TRANSITIONS OF ^{38}Cl, ^{42}K, AND ^{88}Rb BY THE METHOD OF $\beta-\gamma$ ANGULAR CORRELATIONS. Hess, R. (Laboratoire de Physique des Hautes Energies, Zurich). Helv. Phys. Acta, 41: 77-119(1968). (In French).

First-forbidden beta transitions of the type $2^- \beta\ 2^+$ were studied in the decays of ^{38}Cl and ^{42}K by measuring $\beta-\gamma$ directional correlations and $\beta-\gamma$ circular polarization correlations. Large negative values of the anisotropy factors, particularly in the case of ^{38}Cl, confirmed that these β transitions cannot be described by the ξ-approximation. Therefore, all the nuclear matrix elements (NME) may be computed from the experimental data and the available results of shape factor measurements. The Morita formalism was used. The CVC prediction and the Ahrens-Feenberg relation were assumed for the analysis. Possible deviations from these relations were discussed. The results are characterized by the perdominance of the NME of tensor order zero ($\int\sigma\cdot r$ and $\int\gamma_5$) and by a non-vanishing value of $\int B_{ij}$. The NME of tensor order one are completely absent in one of the solutions. An attempt was made to explain these results within the framework of the shell model with configuration mixing. The analogue β transition in the decay of ^{88}Rb was also investigated. The $\beta-\gamma$ directional correlation was measured. A large positive anisotropy factor was found, which rules out the ξ-approximation in this case also. (auth)

15974 SECOND BIENNIAL REPORT OF ACTIVITIES OF THE JAPANESE NUCLEAR DATE COMMITTEE (1965 AND 1966). Nippon Genshiryoku Gakkaishi, 9: 604-10(Oct. 1967). (In Japanese).

A biennial progress report is presented for the Japanese Nuclear Data Committee for the years 1965 and 1966. The main subjects reviewed are: (1) Exchange of data and information through IAEA and ENEA, (2) preparation of reports of activity and compilation of lists of requests for measurements, (3) compilation and evaluation of nuclear data, (4) theoretical calculations of unknown neutron cross sections, and (5) preparation of group constants to be used in reactor calculations. A list is appended of reports and technical documents published and under preparation in the period covered. (auth)

15975 STUDY OF THE ANGULAR DISTRIBUTION OF THE (n,α_0) REACTION ON ^{40}Ca FOR NEUTRONS OF 5.13 MeV. Abaschi, Hamadi; Salin, Raymond; Depraz, Jean (Univ., Lyon). Compt. Rend., Ser. A and B, 265: 1265-6(Nov. 27, 1967). (In French).

The angular distribution of the (n,α_0) reaction on ^{40}Ca was determined at a neutron energy of 5.13 MeV using junction detectors. The curve has a regular decrease from 0 to 180°. (tr-auth)

15976 EXCITATION FUNCTIONS AND ANGULAR DISTRIBUTIONS OF THE REACTION ^{41}K(p,α)^{38}Ar. Buhs, R.; Richard, H.; Riech, V. (Institut fuer Experimentalphysik, Hamburg). Z. Phys., 210: 32-42(Feb. 5, 1968). (In German).

Excitation functions at 90 and 155° to the proton beam were measured for the reaction ^{41}K(p,α)^{38}Ar from 2.1- to 2.5-MeV proton energy. Twenty-nine resonances were identified within this energy region. In order to determine spins and parities of at least some of these resonances, angular distributions were measured at 11 different energies. Single-level analysis was possible in five cases and yielded unique spin-parity assignment for three ^{38}Ar levels. In two cases, two or three different spin-parity combinations were equally possible. The partial width parameters deduced from this analysis are discussed. (auth)

15977 ISOMERIC CROSS-SECTION RATIOS FOR $2p_{\frac{1}{2}}$ AND $1g_{\frac{9}{2}}$ SHELL-MODEL STATES FORMED BY THERMAL NEUTRON CAPTURE. Mannhart, W.; Vonach, H. K. (Technische Hochschule, Munich). Z. Phys., 210: 13-31(Feb. 5, 1968). (In German).

Thermal capture cross sections and isomeric cross-section ratios in thermal neutron capture were determined for even-even nuclei in the region of the $2p_{\frac{1}{2}}-1g_{\frac{9}{2}}$ neutron shell. Capture cross sections for formation of ^{69m}Zn, ^{71m}Zn, ^{71}Zn, ^{71}Ge, ^{75m}Ge, ^{77m}Ge, ^{77m}Se, ^{79m}Se, ^{83m}Se, ^{83}Se, ^{85m}Sr, and ^{87m}Sr were measured by the activation method. From these data and additional measurements of cross-section ratios, the isomeric ratios for thermal capture in ^{68}Zn, ^{70}Zn, ^{70}Ge, ^{74}Ge, ^{76}Ge, ^{76}Se, ^{78}Se, ^{80}Se, ^{82}Se, and ^{84}Sr were determined. In addition epithermal capture isomer ratios were determined for ^{68}Zn, ^{74}Ge, ^{76}Ge, ^{80}Se, and ^{84}Sr. The isomer ratios are compared with calculations based on the statistical model of Huizenga and Vandenbosch. With the exception of ^{80}Se, the measured ratios can be explained theoretically with reasonable values of the spin-cutoff factor σ and gamma-ray multiplicity N; however, there seems to be unexplained difference in either σ or N between the two groups of nuclei leading to either $\frac{1}{2}-\frac{7}{2}$ or $\frac{1}{2}-\frac{9}{2}$ isomers. (auth)

15978 ISOBARIC ANALOGUE RESONANCES IN (p,n) REACTIONS ON ^{78}Se, ^{80}Se, ^{82}Se, AND ^{87}Rb. Zioni, J.; Jaffe, A. A.; Drory, Ch.; Harchol, M. (Hebrew Univ., Jerusalem). Nucl. Phys., A109: 401-6(1968).

Excitation functions for the reactions ^{78}Se(p,n)^{78}Br, ^{80}Se(p,n)^{80}Br, ^{82}Se(p,n)^{82}Br, and ^{87}Rb(p,n)^{87}Sr were investigated, and isobaric analog resonances were identified. The total widths of several of the resonances were determined. The Coulomb-displacement energies for the isobaric pairs ^{79}Se–^{79}Br, ^{81}Se–^{81}Br, ^{83}Se–^{83}Br, and ^{88}Rb–^{88}Sr were found to be 10.50 ± 0.05, 10.487 ± 0.015, 10.56 ± 0.05, and 11.16 ± 0.09 MeV, respectively. (auth)

15979 A STUDY OF ^{61}Ni BY THE ^{59}Co(^{3}He,p)^{61}Ni REACTION. Cosman, E. R.; Schramm, D. N.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A109: 305-15(1968). (MIT-2098-388).

The ^{59}Co(^{3}He,p)^{61}Ni reaction was studied at 11.65 MeV incident energy. The ^{61}Ni levels found were compared with previous high-resolution ^{60}Ni(d,p)^{61}Ni studies. Angular distributions for 20 prominent transitions were extracted, and, although no DWBA analysis was performed, the presence of L = 0 amplitudes was tentatively deduced. The positions of possible proton core-excited states of two-particle–one-hole character were suggested, and a discussion of these results in terms of intermediate structure is given. (auth)

15980 DIRECT AND COMPOUND NUCLEAR REACTION MECHANISMS BY ^{26}Mg(p,p)^{26}Mg. Haeusser, O. (Max Planck Institut fuer Kernphysik, Heidelberg); Richter, A.; Von Witsch, W.; Thompson, W. J. Nucl. Phys., A109: 329-46(1968).

The reaction ^{26}Mg(p,p') was studied for proton bombarding energies between 8.3 and 14 MeV. Excitation functions measured in 30 keV steps at five backward angles showed pronounced fluctuations for the transitions into the different final states. The cross sections for the (p,p_0), (p,p_2), and (p,p_4) reaction were analyzed in terms of the various correlation functions of the statistical theory and compared with statistical-model predictions. Allowance was made for finite range of data errors. In general, the

fluctuations were found to be damped by direct reaction contributions, the relative contributions of which were estimated for the elastic scattering by two methods. The first method used the variance of the fluctuating cross sections, whereas the second one employed an analysis of the energy-averaged angular distributions by means of the optical model plus Hauser–Feshbach estimates for the compound nucleus cross sections. (auth)

15981 LEVEL WIDTHS IN ^{31}P. Hough, J. H.; du Toit, Z. B.; Mouton, W. L. (Univ. of Stellenbosch, S. Afr.). Nucl. Phys., A109: 393-400(1968).

Gamma rays of energy 8.201 MeV from the reaction ^{30}Si(p,γ)^{31}P at E_p = 945 keV were resonantly absorbed in red phosphorus powder. The widths of the absorption curves obtained for three different absorber thicknesses were instrumental and determined primarily by the width of the absorber. The level parameters were calculated from the absorption integrals and an independent relative yield measurement. An attempt was also made to determine the level parameters from the variation of the absorption intergral with absorber thickness. The following results were obtained: Γ_t = 2.6 ± 0.2 eV, and $\Gamma_{\gamma 0}$ = 1.4 ± 0.1 eV. The total width of the 7.90 MeV level at E_p = 622 keV was also determined. Three different absorber thicknesses were used. The results obtained, viz. Γ_t = 68 ± 9 eV, and $\Gamma_{\gamma 0}$ = 1.6 ± 0.2 eV, are in reasonable agreement with a previous measurement. (auth)

15982 STATES WITH T = 1 IN ^{20}Ne, ^{24}Mg, AND ^{28}Si. Lawergren, B. T.; Ferguson, A. T. G.; Morrison, G. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A108: 325-36(1968).

The T_z = 0 analogs of states up to ≈2 MeV excitation in ^{20}F and ^{24}Na were located by measuring the (d,n) reactions and comparing them to the (d,p) reactions. Higher-lying analog levels of these nuclei and of ^{28}Al were identified by relating the known (p,γ) and (d,p) reactions. Some 20 new levels were classified at (T,T_z) = (1,0) states. The relative excitation energies of (1,0) and (1,1) states are strikingly similar although energy shifts of up to 100 keV occur for a few levels. (auth)

15983 ISOSPIN SELECTION RULE IN THE ^{28}Si(d,α)^{26}Al REACTION. Bizzeti, P. G.; Bizzeti-Sona, A. M. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A108: 274-88(1968).

The reaction ^{28}Si(d,α)^{26}Al was investigated in the energy interval 6.98 to 11.06 MeV. Excitation functions for the transitions to six levels of ^{26}Al were measured in small energy steps. Average values and fluctuation amplitudes of the differential cross sections were compared with the predictions of the statistical model. A general agreement has been found for the allowed transitions, while the cross section for the forbidden transition to the ^{26}Al first excited state is smaller by a factor 0.25 ± 0.05 than the calculated value. The hindrance can be interpreted as an effect of the isospin selection rule. A value $\Gamma \approx 75$ keV was deduced for the coherence width of the "allowed" transitions. There is some indication of a smaller width for the α_1 transition. (auth)

15984 BETA DECAY OF ^{18}Ne, ^{23}Mg, ^{26}Si, AND ^{27}Mg. Gorodetzky, S.; Aslanides, E.; Gallmann, A.; Frick, G. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., A109: 417-22 (1968). (In French).

Gamma-ray spectra from the β-decay of ^{18}Ne, ^{23}Mg, ^{26}Si, and ^{27}Mg were measured with Ge(Li) detectors having sensitive volumes up to 24 cm^3. The β-decay branching ratios and corresponding log ft values are calculated, and upper limits for unobserved weak branches are given. Lifetime measurements were carried out for ^{27}Mg. (auth)

15985 ANALYSIS OF (^{3}He,α) REACTIONS ON ^{25}Mg AND ^{26}Mg AT 5.50 MeV. Galassini, S.; Pellegrini, F. (Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., (10) 53B: 188-94(Jan. 11, 1968).

The results obtained in (^{3}He,α) reactions on ^{25}Mg and ^{26}Mg nuclei at a bombarding energy of 5.50 MeV are analyzed in terms of Hauser–Feshbach theory using finite values of the spin cut-off parameter σ^2. The calculated spectroscopic factors are compared directly with the experimental spectra, which show large deviations from the prediction of a direct neutron pick-up theory. These large deviations consist in a yield of the α particles, leaving the residual nuclei in the low-lying excited states, higher than the predicted one. Calculations using a value of σ^2 = 2 for the spin cut-off parameter were found to give best agreement between theory and experiment for reactions with both ^{25}Mg and ^{26}Mg. (S.F.L.)

15986 ELECTROMAGNETIC PROPERTIES OF ^{39}K BOUND STATES. Lopes, J. S.; Robertson, B. C.; Gill, R. D.; Bell, R. A. I.; Rose, H. J. (Oxford Univ.). Nucl. Phys., A109: 241-64(1968).

The ^{39}K energy levels located at 2.53, 2.82, 3.02, 3.60, 3.88, and 3.94 MeV were studied in the ^{42}Ca(p,α)^{39}K and ^{39}K(p,p')^{39}K reactions using an angular correlation technique to gain information on the spins and mixing ratios of the de-excitation radiation. The 2.53 MeV level shows an isotropic distribution in agreement with its assignment of $J^\pi = \frac{1}{2}^+$. The 2.82 MeV level has $J^\pi = \frac{1}{2}^-$, mixing ratio $\delta(2.82 \rightarrow 0) = -0.19 \pm 0.10$, an E3/M2 mixture. The 3.02 MeV level has $J^\pi = \frac{3}{2}^-$, $\delta(3.02 \rightarrow 0) = -0.03 \pm 0.15$, an M2/E1 mixture. The 3.60 MeV level has $J^\pi = \frac{5}{2}^-$ or $\frac{1}{2}^-$; it decays to the 2.82 MeV level (39%) and to the ground state (61%); the magnitude of $\delta(3.60 \rightarrow 2.82)$ is large for both possible spin values; $|\delta(3.60 \rightarrow 0)| < 0.36$ if $J = \frac{5}{2}$ and $-0.36 < |\delta(3.60 \rightarrow 0)| < -0.14$ if $J = \frac{1}{2}$. The 3.88 MeV level decays to the ground state; $J = \frac{1}{2}$ is excluded, and the values $J = \frac{3}{2}, \frac{5}{2}$ are suggested. The decay schemes of the levels at 3.94, 4.08, 4.09, 4.12, 4.47, 4.51, 4.68, and 4.74 MeV are investigated. Spin values are suggested for some of these levels by combining the present results with previously reported results obtained in direct reaction studies. The results obtained are discussed, and a weak coupling model calculation is used to estimate the 2.82 MeV ground state transition mixing ratio. (auth)

15987 M/L ORBITAL-ELECTRON-CAPTURE RATIO IN ^{37}Ar DECAY AND THE FRACTION OF K_α X RAYS IN THE K SERIES OF CHLORINE. Renier, J. P.; Genz, H.; Ledingham, K. W. D.; Fink, R. W. (Georgia Inst. of Tech, Atlanta). Phys. Rev., 166: 935-45(Feb. 20, 1968).

The ratio of M- to L-orbital electron capture in the decay of 35-day ^{37}Ar was measured in a single-wire proportional counter containing the gaseous source. This counter was operated with variable paralysis times, 2.0 and 3.8 msec being used in the present experiments to minimize the contribution from afterpulses. Recent investigations of the pulse-height distribution from proportional counters due to single- and multiple-electron events make it possible to measure single-electron spectra down to essentially zero energy with much greater accuracy than heretofore. The experiment was undertaken because of the considerable disagreement between experimental and theoretical M/L capture ratios, particularly in the low-Z region. A survey of all experimental work on M capture is included for comparison with available theoretical results. In the decay of ^{37}Ar the experimental value for the M/L capture ratio is $P_M/P_L = 0.104^{+0.008}_{-0.003}$, where the error limits have been subjected to careful detailed analysis. From this result, a value of $k_\alpha = 0.980 \pm 0.015$ for chlorine was determined, where k_α is the fraction of k_α x rays in the K series of chlorine. The theoretical predictions of Bahcall for P_M/P_L lie about 23% above the experimental point, for a theory with exchange correction. The older theoretical value due to Wapstra et al. is in no better agreement with experiment, even if a correction for exchange is applied. An intensive effort is reported to measure the L/K capture ratio in the decay of 53.5-day ^{7}Be, as gaseous $(C_2H_5)_2{}^7$Be in the single-wire proportional counter, but owing to the low energy of the K-capture events (55 eV) and very low counting statistics, this measurement appears to be beyond the present state of the proportional-counter art. (auth)

15988 DECAY OF ^{72}Ga (14h) TO ^{72}Ge. El-Nesr, M. S.; Awwad, Z. (Atomic Energy Establishment, Cairo). Nuovo Cim., (10) 53B: 98-111(Jan. 11, 1968).

The photoconversion spectrum from gamma-rays of energies greater than 200 keV, following the decay of 14 h ^{72}Ga, was studied using a high-resolution double-focusing beta-ray spectrometer. The photoelectrons are produced from uranium radiator of thickness 2.9 mg/cm^2. The resulting momentum resolution was 0.3 to 0.8% depending on energy. In addition to gamma-rays previously reported, 11 new gamma-rays with energies of 293.62, 424.97, 650.41, 774.64, 943.12, 1180.8, 1339.8, 1679.8, 1716.0, 1824.7, and 2910.0 keV were observed. On the basis of a statistical analysis of sum relationships for the transition energies, combined with earlier coincidence results, a decay scheme involving 15 excited levels is suggested. The relative gamma-ray intensities were determined from the external-conversion spectrum applying the corrections for the angular dependence of the photoelectric process. Gamma energies and intensities higher than 2.5 MeV were investigated by means of a scintillation spectrometer using a RIDL transistorized 400-channel analyzer. The absolute K-internal-conversion coefficients of 449, 510, 595, 650, 671, 718, 786, 810, and 894 keV transitions were measured for the first time; the multipolarity assignments of these transitions were studied on the basis of the conversion coefficients. From our measurements together with the previously known assigned levels, the spins and parities 4^+, 2^+, 2^+, 3^+, 2^+, 1^+, 3^-, and 3^- are established for the 1729, 2060, 2515, 2625, 2849, 2910, 3050, and 3325 keV levels respectively in ^{72}Ge. (auth)

15989 AKHIESER–POMERANCHUK–BLAIR MODEL ANALYSIS FOR ELASTIC SCATTERING OF DEUTERONS. Rahman, M.

(Atomic Energy Centre, Dacca, East Pakistan); Khan, A. H.; Sen Gupta, H. M. Aust. J. Phys., 21: 7-11(Feb. 1968).

Angular distributions of deuterons elastically scattered from Mg, Fe, Cu, and Zn were analyzed in terms of the smoothed Akhieser–Pomeranchuk–Blair model and reasonable agreement was obtained in each case up to about 90°. The interaction radius R and the surface thickness ΔR were obtained from the best-fit parameter values. (auth)

15990 THE REACTION ^{25}Mg(^{3}He,d)^{26}Al AT 12 MeV. Weidinger, A. (Yale Univ., New Haven); Siemssen, R. H.; Morrison, G. C.; Zeidman, B. Nucl. Phys., A108: 547-60(1968).

The ^{25}Mg(^{3}He,d)^{26}Al reaction was studied at E(^{3}He) = 12 MeV by use of the Argonne tandem Van de Graaff and a broad-range magnetic spectrograph. All known states up to 4.2 MeV were observed in this experiment; but the doublets at 2.07 MeV and 4.20 MeV were not resolved. For the 15 strongest transitions, angular distributions between 5° and 25° were measured. They all have characteristic l = 0, l = 2 or l = 0 + 2 stripping patterns. The l = 0 admixtures in the angular distributions limit spins and parities to 2^+ or 3^+ for the states at 2.55, 2.92, 3.59, 3.68, and 3.75 MeV, for which no spins and parities were previously known. Spectroscopic factors were extracted with the Oak Ridge DWBA code Julie. The results are discussed in the framework of the unified model. (auth)

15991 ENERGY LEVELS OF ^{57}Co. Bouchard, Noel; Cujec, Bibiana (Univ., Laval, Quebec). Nucl. Phys., A108: 529-34 (1968).

The reaction ^{54}Fe(α,p)^{57}Co was used to study the energy levels of ^{57}Co up to 4 MeV excitation with 25 keV resolution. Several new levels were found, and it is proposed that the levels at 1.22 and 1.68 MeV have spin and parity $^5/_2^-$ and $^{11}/_2^-$, respectively. (auth)

15992 A STUDY OF THE LOW-LYING ISOBARIC ANALOGUE STATES OF ^{89}Sr BY MEANS OF THE ^{88}Sr(p,p) AND (p,p′) REACTIONS. Cosman, E. R. (Massachusetts Inst. of Tech., Cambridge); Joyce, J. M.; Shafroth, S. M. Contract AT(30-1)-2098. Nucl. Phys., A108: 519-28(1968).

The isobaric analog states of levels in ^{89}Sr are studied here as virtual states in ^{89}Y by means of elastic and inelastic proton scattering on ^{88}Sr. A total of 15 analogue states is identified within a range of incident energies from 4.9 to 8.7 MeV by observing resonances in the $p_0(0^+)$, $p_1'(2_1^+)$ and $p_2(3^-)$ channels at several scattering angles. On-resonance angular distributions for the $p'(2^+)$ and $p'(3_1^-)$ transitions have been measured in a number of cases. The former inelastic distributions show significant asymmetries about 90° at energies where elastic resonances are also present suggesting the existence of direct interference processes. One example is shown of a 3^- state angular distribution where the $p_2(3^-)$ channel resonates strongly, whereas the elastic p_0 channel does not. In this case, the pattern appears symmetric, and a tentative analogue spin assignment is deduced. Simple Breit-Wigner curves have been compared with the data, and estimates of the single-particle reduced widths are given. The energetic and spectroscopic information so obtained is then compared with that from the ^{88}Sr(d,p)^{89}Sr reaction performed with high resolution. (auth)

15993 NEUTRON–GAMMA CORRELATION STUDIES OF THE ^{28}Si(d,n)^{29}P REACTION AT DEUTERON ENERGIES NEAR 3 MeV. Felst, R.; Cosack, M.; Gudehus, T.; Siemssen, R. H.; Tepel, J.; Zeitnitz, B. (Univ., Hamburg). Nucl. Phys., A108: 666-88(1968).

Angular distributions and excitation functions of the neutron groups leading to the ground, first and second excited state in ^{29}P were measured in the deuteron energy range from 2.7 to 3.3 MeV. In addition, (d,n,γ) angular correlations were measured in and out of the reaction plane with the neutron detector at an angle of 45° with respect to the direction of the incident deuteron beam. The data were analyzed in the framework of the DWBA stripping theory. The direct amplitude was found to dominate. However the DWBA theory does not describe the reaction in detail. Fluctuations observed in the excitation functions are in agreement with the predictions of the statistical theory. (auth)

15994 A STUDY OF THE NUCLEAR STRUCTURE OF ^{28}Si BY THE ^{28}Si(p,p′)^{28}Si REACTION. Barnard, R. W.; Jones, G. D. (Univ. of Colorado, Boulder). Nucl. Phys., A108: 655-65 (1968). (COO-535-575).

Angular distributions to the ground and first five excited states of ^{28}Si were measured for the ^{28}Si(p,p′)^{28}Si reaction at a bombarding energy of 21.2 MeV. An analysis was carried out describing the inelastic proton angular distributions in terms of the collective model. An attempt has also been made to describe the data in terms of simple particle-hole shell-model configurations. Shell model form factors are used in distorted wave calculations, the requirement being that a particular configuration satisfies both ^{27}Al(^{3}He,d)^{28}Si and ^{28}Si(p,p′)^{28}Si data. (auth)

15995 A STUDY OF THE NUCLEAR STRUCTURE OF ^{28}Si BY THE ^{27}Al(^{3}He,d)^{28}Si REACTION. Barnard, R. W.; Jones, G. D. (Univ. of Colorado, Boulder). Nucl. Phys., A108: 641-54(1968). (COO-535-574).

Angular distributions to the ground state and 12 excited states of ^{28}Si were measured for the ^{27}Al(^{3}He,d)^{28}Si reaction at a bombarding energy of 37.7 MeV. The ^{27}Al(^{3}He,^{3}He)^{27}Al angular distribution was also obtained at the same energy. The angular distribution to the ground state of ^{28}Si is characteristic of a proton transfer of l_p = 2 expected from the closing of the $1d_{\frac{5}{2}}$ proton shell. The next-higher excited states show angular distributions with more than one l_p value contributing indicating that the $(1d_{\frac{5}{2}})^{-1}(2s_{\frac{1}{2}}$ or $1d_{\frac{3}{2}})$ proton particle-hole configurations are mixed. The experiments confirm that the low-lying states of ^{28}Si are mainly of positive parity and allow tentative spin assignments to some of the states. (auth)

15996 EXCITATION FUNCTIONS FOR DEUTERON-INDUCED REACTIONS. Otozai, K. (Osaka Univ.); Kuze, S.; Okamura, H.; Mito, A.; Nishi, T.; Fujiwara, I. Nucl. Phys., A107: 427-35 (1968).

Excitation functions for reactions induced by deuterons on ^{70}Ge, ^{96}Zr, and ^{130}Te were measured with the activation method up to 14.1 MeV deuteron energy. The observed reactions are ^{70}Ge(d,p)^{71}Ge, (d,n)^{71}As, (d,2n)^{70}As and (d,α)^{68}Ga, and ^{96}Zr(d,p)^{97}Zr, (d,n)^{97}Nb, (d,2n)^{96}Nb, (d,3n)^{95}Nb, ^{130}Te(d,p)^{131}Te, (d,n)^{131}I, and (d,2n)^{130}I. The results were explained with a modified Peaslee theory presented previously for ^{142}Ce data. Excitation functions of ^{96}Zr, ^{130}Te, and ^{142}Ce give the common values of variable parameters and a common pattern regarding relative contributions of neutron stripping, proton stripping and entire absorption processes. The situation is quite different for ^{70}Ge. (auth)

15997 APPLICABILITY OF ^{36}Cl FOR VERIFYING THE TIME REVERSAL INVARIANCE OF NUCLEAR FORCES. Kajfosz, J.; Honzatko, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 18: 152-3(1968).

The application of an experimental method of investigating time reversal invariance of nuclear forces which is based on seeking the anomalous interference terms in the correlation functions of cascade γ-transitions in ^{36}Cl oriented by the capture of polarized neutrons is proposed. The method would involve a study of the 7.79-MeV transition from the capture state with 2^+ spin to the first excited state at 0.788 MeV, and the transition of this level to the ground state. (S.F.L.)

15998 MIXING RATIO OF THE 0.34 MeV (M1 + E2) TRANSITION IN ^{49}Ti. Honzatko, J.; Kajfosz, J.; Kopecky, J. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., 18: 34-8(1968).

A direction-polarization correlation experiment was carried out in order to remove the ambiguity of the mixing ratio of the 0.34 MeV transition in ^{49}Ti. The result of this experiment gives sufficient proof that the value is $\delta = +0.1$. (auth)

15999 SCATTERING OF ^{3}He FROM MEDIUM-WEIGHT NUCLEI AT 37.7 AND 43.7 MeV. Gibson, Edward Fergus. Boulder, Colo., Univ. of Colorado, 1966. 188p.

Thesis.

The scattering of 37.7 and 43.7 MeV ^{3}He ions from medium weight nuclei was studied in order to investigate both the optical model for ^{3}He, and ^{3}He as a nuclear spectroscopic tool. ^{3}He ions were scattered from ^{40}Ca, ^{56}Fe, and ^{58}Ni at 37.7 MeV and from ^{58}Ni, ^{89}Y, and ^{90}Zr at 43.7 MeV. The energy resolution ranged from 100 to 200 keV. Elastic angular distributions were obtained in the angular range from 3° to about 90° for all targets and were extended to 120° in the case of ^{90}Zr. Inelastic distributions for the more strongly excited states were obtained in the angular range from 15° to about 90°. The (^{3}He,α) reaction was also observed for the target nuclei ^{58}Ni, ^{89}Y, and ^{90}Zr. The elastic angular distributions exhibit rapid oscillations and decrease rapidly from point Rutherford scattering, as a function of scattering angle. The optical model is demonstrated to adequately describe the elastic ^{3}He scattering; however, many different potentials are shown to give equally good fits. Both discrete and continuous optical model parameter ambiguities giving about the same fit to the data, in a least squares sense, were found. These different potentials produce approximately the same reflection coefficients for each partial wave, and the major difference in the potentials corresponding to the discrete ambiguities is in the number of half wave lengths held for small angular momentum partial waves. The elastic scattering is shown to occur mainly in the surface region of the potential, where the potential is nearly the same for all

optical model potentials giving good fits to the data. The dependence of the optical model potential upon incident energy and atomic mass of the target is shown to be slight when the potential geometries are held fixed. The ability of the distorted wave theory using a collective model interaction to correctly predict the angula momentum transfer, is investigated by comparing the predicted with the experimental angular distributions for states of well known spin and parity. The theory is also used to predict the angular momentum transfer in exciting other states. To obtain adequate descriptions with this theory, a complex potential interaction is found necessary, the imaginary term being the dominant term in the interaction. The calculated distortion parameters are in reasonable agreement with other results. The (^{3}He,α) reaction is shown to be very useful in studying states of nuclei obtained by neutron pickup, and several new states in ^{89}Y and ^{91}Zr are found. (Disser. Abstr.)

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Refer also to abstracts 14433, 14513, 14751, 14792, 14828, 14831, 14832, 14834, 14835, 15336, 15659, 15688, 15737, 15895, 15996, and 16054.

16000 (CEA-R-3360) MESURE DE LA SECTION EFFICACE DE DIFFUSION DE NOYAUX NON FISSILES PAR LA METHODE DU TEMPS-DE-VOL. DETERMINATION DU SPIN DE QUELQUES ETATS EXCITES. (Measurement of the Scattering Cross Section of Nonfissile Nuclei by the Time-of-Flight Method. Determination of the Spin of Some Excited States). Trochon, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 83p. (In French). Dep.

The Saclay 45-MeV Linear Accelerator is used as a pulsed neutron source to carry out experiments in the resonance energy region. Sometimes, when the right conditions are available, the transmission can give all the resonance parameters such as E_r, Γ_n, $2g\Gamma_n$ and $J = I \pm 1/2$, where I is the spin of the target nucleus. Usually, however, complementary data from scattering measurements are required to obtain the value of spin J. Such experiments have been performed; results obtained on ^{103}Rh and ^{197}Au in the energy range from 40 to 700 eV are presented. (auth)

16001 (GA-7462) NEUTRON CROSS SECTIONS FOR ^{231}Pa, ^{233}Pa, AND ^{232}U. Drake, M. K.; Nichols, P. F. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 8, 1967. Contract AT(04-3)-167. 83p. Dep. CFSTI.

A survey was made of the available experimental cross-section measurements for ^{231}Pa, ^{233}Pa, and ^{232}U. Sets of recommended neutron cross sections and resonance parameters are presented for neutron energies from 0.001 eV to 15 MeV. (D.C.W.)

16002 (GA-8133) NEUTRON CROSS SECTIONS FOR NIOBIUM. Allen, M. S.; Drake, M. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 2, 1967. Contract AT(04-3)-167. 71p. Dep. CFSTI.

The neutron cross sections for Nb that have been prepared for the Evaluated Nuclear Data File (ENDF/B) as part of the cooperative effort by the Cross Section Evaluation Working Group are described. The cross sections were prepared from sets of previously evaluated data and from data that were obtained in an attempt to complete the existing data. (D.C.W.)

16003 (GA-8135) NEUTRON CROSS SECTIONS FOR ^{234}U AND ^{236}U. Drake, M. K.; Nichols, P. F. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 1, 1967. Contract AT(04-3)-167. 76p. Dep. CFSTI.

A survey was made of the available experimental cross-section measurements for ^{234}U and ^{236}U. Sets of recommended neutron cross sections are presented for neutron energies from 0.001 eV to 15 MeV. Resonance parameters are also included. (D.C.W.)

16004 (INR-P-843/IA/PL) QUADRUPOLE MOMENT OF THE $K^\pi = 0^+$ EXCITED STATE IN ODD ^{177}Lu. Jastrzebski, J.; Moszynski, M.; Preibisz, Z.; Stryczniewicz, K.; Paris, P.; Treherne, J. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 16p. Dep.

An investigation of ^{177}Hf($T_{1/2}$ = 5 yr) decay was carried out after the sample was chromatographically purified of the daughter ^{177}Lu (6.5 day) isotope. The half-lives of the 110-keV (2^+) and 192 keV (1^+) states of ^{177}Lu were measured to be 2.30 ± 0.12 nsec and ≤0.5 nsec, respectively. The B(E2) of the 44-keV transition is calculated assuming the theoretical conversion coefficient α_T = 1.31. The value obtained for B(E2)↑ is 5.60 ± 0.28 × 10^{-48} e^2 cm^2. Assuming no band mixing the intrinsic quadrupole moment of the $\{p^1/_2 + [404]; n^7/_2 + [633]\}$ K = 0 rotational band was determined to be Q_{02} = 7.50 ± 0.20 barns. The γ-ray intensities measured with Ge(Li) detectors confirm the decay scheme of Valentin et al. and Harmatz and Handley. (auth)

16005 (IS-1730) MEASUREMENTS OF SOME GAMMA-RAY RELATIVE INTENSITIES AND INTERNAL CONVERSION COEFFICIENTS USING A BENT-CRYSTAL MONOCHROMATOR. Nelson, Gerald C.; Hatch, E. N. (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 149p. Dep. CFSTI.

The x-ray and gamma-ray relative intensities were measured from the decay of ^{170}Tm, ^{166}Ho, ^{180m}Hf, ^{155}Eu, and ^{155}Sm with a bent-crystal monochromator and a linear least-squares computer program. The K-shell internal conversion coefficients were determined for the E2 transitions in ^{170}Yb and ^{166}Er. The K-shell conversion coefficient, α_K, for the 84.3-keV transition in ^{170}Yb was determined to be 1.43 ± 0.04 while the K-shell internal conversion coefficient for the 80.6-keV transition in ^{166}Er was determined to be 1.72 ± 0.06. The results for these $2^+ \rightarrow 0^+$ transitions are five percent higher than the theoretical values for these transitions. From the relative intensities of the transitions in ^{180}Hf, it was possible to deduce a value for the total internal conversion coefficient for the 93.3-keV transition of α_T^{93} = 4.91 ± 0.23. Using the previous measurements of conversion electron intensities of Edwards and Boehm and the present measured gamma-ray relative intensities, internal conversion coefficients for all the other transitions were obtained. The present measurements of α_K for the 215.3-, 332.5-, and 443.8-keV E2 transitions are 11 percent lower than the theoretical values, while α_K for the 93.3-keV E2 transition agrees closely with the theoretical value. These results are in close agreement with the previous measurements of Edwards and Boehm. The present value for α_K for the 501-keV transition agrees closely with the theoretical α_K for an E3 multipolarity. From the X-ray and gamma-ray relative intensities of the transitions in ^{155}Gd and the previous measurement of the ratio of K conversion electrons for the 86- and 105-keV transitions of Subba Rao, it was possible to determine the K conversion coefficients for the 86- and 105-keV transitions of α_K = 0.43 ± 0.06 and α_K = 0.23 ± 0.03. These results are in agreement with the theoretical values for pure E1 transitions. The relative intensities of the 246-, 142-, and 104-keV gamma rays following the decay of 22-min ^{155}Sm were determined with improved precision in order that they might be used to determine accurately the conversion coefficients for these transitions. (auth)

16006 (JINR-D7-3623) PERSPEKTIVY SINTEZA NOVYKH IZOTOPOV I ELEMENTOV. (Perspective Views on the Synthesis of New Isotopes and Elements). Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 18p. (In Russian). Dep.

The synthesis of new isotopes and elements is discussed. Methods of producing new isotopes, including neutron reactions, heavy-ion reactions, and heavy ion-induced fission are considered. (D.C.W.)

16007 (JINR-P6-3540) NOVYE IZOMERNYE SOSTOYANIYA PRI RASPADE KOROTKOZHIVYSHCHIKH IZOTOPOV ^{140}Sm, ^{141}Sm, ^{140}Pm O RASPADE IZOTOPA ^{142}Pm. (New Isomeric States by the Decay of Short-Lived Isotopes of ^{140}Sm, ^{141}Sm, ^{140}Pm; On the Decay of ^{142}Pm). Ari't, R.; Baier, B.; Muziol, G.; Peker, L. K.; Pfrepper, G.; Shtrusnyi, Kh.; Khristov, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 21p. (In Russian). Dep.

Positron emission from the decay of ^{140}Sm and γ spectra from the ^{140}Sm and ^{141}Sm decays were measured. Data on the existence of two new isomeric states in the ^{140}Pm and ^{141}Sm nuclei are given. (auth)

16008 (JINR-P6-3660) NOVYE DANNYE O SKHEME RASPADA ^{159}Er. (New Data on the Decay Scheme of ^{159}Er). Abdurazakov, A. A.; Kalinnikov, V. G.; Zhelev, Zh. T.; Nazarov, U. K.; Urbanets, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 12p. (In Russian). Dep.

The γ-ray spectra and conversion-electron spectra of ^{159}Er were investigated. New γ transitions with the energies 582, 608, 649, and 837 keV were observed. The half-life of ^{159}Er was measured to be 37 ± 2 min. The multipolarities of γ transitions were determined. New energy levels at 624.4 keV ($5/2^-$, [523]) and 649.5 ($5/2^+$, [413]) are suggested. The level scheme of the ^{159}Ho is discussed. (auth)

16009 (JINR-P7-3630) ISSLEDOVANIE SVOISTV KOROTKOZHIVYSHCHIKH YADERNYKH SOSTAVNYKH SISTEM. (Investigation of Short-Lived Nuclear System Properties). Lozhinski, E.; Chuburkova, I. I. (Joint Inst. for Nuclear Research,

Dubna (USSR). Lab. of Nuclear Reactions). 1967. 11p. (In Russian). Dep.

The decay of the compound system of [^{197}Au + ^{40}Ar] nuclei in ≈10-particle transfer reactions was investigated. To study the angular distributions, a method of assembled foils was used. The angular distributions of the reactions ^{197}Au(^{40}Ar,^{47}Sc)^{190}Os and ^{197}Au(^{40}Ar,^{28}Mg)^{209}At for the energies (cms) ≈155, 170, and 195 MeV were investigated. The total cross sections and the upper limits of the cross sections of a number of reactions, in which about 16 particles are transferred, are given. (auth)

16010 (JINR-P7-3673) ISSLEDOVANIE SVOISTV SPONTANNO DELYASHCHEGOSYA IZOMERA ^{246}Cf. (Investigation of the Properties of a Spontaneously Fissionable Isomer ^{246}Cf). Gangrskii, Yu. P.; Markov, B. N.; Polikanov, S. M.; Kharisov, I. F.; Yungklaussen, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 15p. (In Russian). Dep.

Excitation functions of the reaction ^{238}U(^{12}C,4n), leading to a spontaneously fissionable isomer ^{246}Cf (half-life ≈ 5.10^{-3} sec) and to the ground state of ^{246}Cf, were investigated. The time-of-flight method of recoil nuclei, knocked out by the bombarding ions, was used in the experiment. From the comparison of the excitation functions, one can suppose that the energy of the isomeric state is comparatively large (>1 MeV). The cross-section ratio of ^{246}Cf production in isomeric and ground states equals 10^{-2}, what is considerably larger than in the case of the reactions leading to the Am isomers with mass number 238, 240, 242, and 244. (auth)

16011 (JUL-503-RX) AKTIVIERUNGS-RESONANZINTEGRAL UND NEUTRONENSELBSTABSCHIRMFAKTOR. (Activation Resonance Integral and Neutron Self-Shielding Factor). Borchardt, G. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Sept. 1967. 32p. (In German). Dep.

For the determination of the neutron flux in the epithermal energy region from 0.2 eV to 100 keV, the knowledge of the activation resonance integral and of the neutron self-shielding factor is necessary. These magnitudes were determined for the nuclides ^{197}Au, ^{186}W, ^{75}As, ^{55}Mn, ^{63}Cu, and ^{23}Na; and the results were compared with the literature values. The probe preparation, the irradiation devices, and the measurement devices are described. (tr-auth)

16012 (KAPL-3327) EVALUATED CROSS SECTIONS FOR THE HAFNIUM ISOTOPES. Reynolds, J. T.; Lubitz, C. R. (Knolls Atomic Power Lab., Schenectady, N. Y.); Itkin, I.; Harris, D. R. (Bettis Atomic Power Lab. [Pittsburgh, Pa.]). Aug. 17, 1967. Contract W-31-109-eng-52. 22p. plus Charts. Dep. CFSTI.

Evaluated libraries of cross sections were prepared for natural hafnium and its isotopes ^{174}Hf, ^{176}Hf, ^{177}Hf, ^{178}Hf, ^{179}Hf, and ^{180}Hf. The libraries contain total, elastic, capture, inelastic, (n,p), and (n,2n) cross sections and elastic scattering Legendre moments below 15 MeV. The most recent experimental data were used in the evaluation; and, whenever data were not available, theoretical calculations were made. (auth)

16013 (LA-3788) CALCULATION OF NEUTRON POLARIZATIONS USING A LOCAL OPTICAL POTENTIAL WITH AVERAGE PARAMETERS. Beery, Jerome G.; Harper, Katherine H.; Stovall, Virginia M.; Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Oct. 1967. Contract W-7405-eng-36. 397p. Dep. CFSTI.

Polarizations resulting from the elastic scattering of neutrons by complex nuclei were calculated for a number of nuclides at energies between 0 and 16 MeV. Comparison is made with experimental data where such are available. The elements and energies were selected on the basis of the AEC's Nuclear Cross Sections Advisory Group request compilation. (auth)

16014 (NP-17208) SPECTRE BETA ET ELECTRONS DE CONVERSION INTERNE DE LA TRANSITION DE 25.6 keV DE LA DESINTEGRATION ^{231}Th → ^{231}U. (Beta and Internal Conversion Electron Spectra of the 25.6 keV Transition in the Decay ^{231}Th → ^{231}U). Cardona, Jean-Bernard (Grenoble Univ. (France). Faculte des Sciences). Sept. 30, 1966. 25p. (In French). Dep.

The beta and internal conversion electron spectra of the 25.6-keV transition was measured using a 21-cm double-focusing magnetic beta spectrometer. The ^{231}Th was separated from the parent isotope ^{235}U by ion exchange, and thin sources were prepared. The spectra obtained are given and are in agreement with those of previous studies. The analysis of the internal conversion electron spectrum confirms the E1 nature of the 25.6-keV transition. (tr-auth)

16015 (NP-17220) REALISATION ET UTILISATION D'UN DETECTEUR γ GERMANIUM POUR ETUDES SPECTROSCOPIQUES DE LA CHAINE DE DESINTEGRATION ^{171}Hf → ^{171}Lu → ^{171}Yb. (Development and Use of a Germanium γ Detector for Spectroscopic Studies of the Decay Chain ^{171}Hf → ^{171}Lu → ^{171}Yb). Peyrard, Michelle (Grenoble Univ. (France). Faculte des Sciences). [1965]. 54p. (In French). Dep.

Thesis.

The general properties of semiconductors are briefly outlined. The techniques used for the preparation of a Li-compensated Ge detector are described in detail. The characteristics of the detector were determined. The decay chain ^{171}Hf → ^{171}Lu → ^{171}Yb was studied to verify the efficiency curve of the detector. The γ radiations detected are tabulated, and the low-energy and high-energy spectra are given. (J.S.R.)

16016 (UCRL-17969) HYPERFINE STRUCTURE OF ^{165}Dy AND SPIN OF ^{163}Er. Stein, Sanford (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 15, 1967. Contract W-7405-eng-48. 69p. Dep. CFSTI.

Thesis.

The atomic-beam magnetic-resonance flop-in method was used to measure the hyperfine structure of ^{165}Dy and the spin of ^{163}Er. The results for the ^{165}Dy ground state are a = ±89.8(7) MHz and b = ∓1520(30) MHz, where a and b are the magnetic dipole and electric quadrupole hyperfine interaction constants. The spin was previously measured to be I = 7/2. From these values one can calculate the nuclear magnetic dipole moment μ_I and the nuclear electric quadrupole moment Q which are μ_I(uncorr) = ∓0.50(4) nm and Q(uncorr) = ±2.8(3) barns. These values are in good agreement with that predicted by the strong deformation collective model. The spin of the ground state of ^{163}Er is I = 5/2 which agrees with the Nilsson state assignment. The theory underlying the atomic-beam method, a description of the technique and equipment used, and a comparison with appropriate theoretical calculations are presented. (auth)

16017 (BNL-tr-189) PARAMETERS OF THE STRUCTURE OF THE NEUTRON FORCE FUNCTION OF MEDIUM AND HEAVY NUCLEI. Sukhoruchkin, S. I. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Nucl. Data Reactors, Proc. Conf. Nucl. Data, Microsc. Sect., Paris, 1966, 1: 159-63(1967). 8p. Dep. CFSTI. JCL $1,10 fs, $0.80 mf.

To obtain reliable values of the force functions when averaging the neutron widths of the individual resonances, it is necessary to fulfill the condition that the averaging interval exceed the characteristic energy period of modulation of the neutron widths, which is related to single-particle effects in the entrance channel. The results of our analysis of the experimental data with a view of determining the parameters of the single-particle structure of the neutron force function are presented. (auth)

16018 INVESTIGATION OF γ RAYS FOLLOWING S- AND P-WAVE NEUTRON CAPTURE IN TIN ISOTOPES. Bhat, M. R.; Chrien, R. E.; Wasson, O. A.; Beer, M.; Lone, M. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 166: 1111-20 (Feb. 20, 1968). (BNL-11797).

The energies and intensities of γ rays following slow-neutron capture in resonances in isotopes of Sn were studied. The angular distributions of γ rays from capture in P-wave resonances in ^{118}Sn, ^{120}Sn, and ^{124}Sn, were measured for several γ rays in order to determine the spins and parities of initial and final states in the reactions. The following assignments for the resonances can be made: ^{117}Sn(38.8 eV, 1$^+$), ^{119}Sn(45.8 eV, 3/2$^-$), ^{120}Sn(426.9 eV, 1/2$^-$), and ^{124}Sn(61.95 eV, 1/2$^-$). The spins of eight final states in ^{119}Sn are assigned by virtue of the nonisotropic angular distribution for γ rays following P-wave capture. New data on the energy levels in ^{119}Sn, ^{121}Sn, and ^{125}Sn are also presented. Results of the present work are compared with the results of (d,p) and other charged-particle reaction studies and theoretical calculations on the tin isotopes. (auth)

16019 NEW ISOTOPE ^{173}Er. Ibochi, H.; Ward, T. E. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Phys. Rev., 166: 1173-7(Feb. 20, 1968). (ORO-3235-27).

Irradiations of natural ytterbium and enriched ^{176}Yb samples were found to produce a new radioactive nuclide, which was assigned to ^{173}Er. The following radiation characteristics were observed to belong to the decay of ^{173}Er: half-life 12.0 ± 0.3 min; β-ray energies 1.8 ± 0.3 and 2.3 ± 0.3 MeV, and relative intensities 30 ± 3 and 70 ± 5, respectively; γ-ray energies 0.087 ± 0.005, 0.100 ± 0.005, 0.115 ± 0.005, 0.128 ± 0.005, 0.155 ± 0.005, 0.182 ± 0.005, 0.197 ± 0.005, 0.205 ± 0.005, 0.278 ± 0.005, 0.300 ± 0.005, 0.365 ± 0.005, 0.380 ± 0.005, 0.395 ± 0.005, and 0.520 ± 0.005 MeV, and relative intensities 10.3 ± 1.0, 6.7 ± 0.5, 7.0 ± 3.5, 4.0 ± 0.5, 18.4 ± 2.5, 20.0 ± 2.0, 59.5 ± 4.0, 4.0 ± 0.6, 5.0 ± 0.8, 3.0 ± 0.5, 18.5 ± 2.0, 19.5 ± 2.0, 30.0 ± 5.0, and 20.0 ± 3.0, respectively.

The cross section for ^{173}Er production through the (n,α) reaction on ^{176}Yb was measured to be 0.20 ± 0.05 mb. (auth)

16020 STRUCTURE OF ^{206}Pb DETERMINED BY THE (d,t) REACTION. Tickle, Robert; Bardwick, John (Univ. of Michigan, Ann Arbor). Phys. Rev., 166: 1167-72(Feb. 20, 1968).

The level structure of ^{206}Pb was studied using the neutron pickup reaction ^{207}Pb(d,t)^{206}Pb with a deuteron bombarding energy of 21.6 MeV. Triton angular distributions have been measured in the angular range 10 to 80° for 14 levels up to 3.3-MeV excitation in ^{206}Pb. The experimental results were analyzed using a distorted-wave Born-approximation calculation to obtain l values and spectroscopic factors. Configuration assignments, consistent with the experimental data and with the distribution of strength predicted by a sum rule, were made for all of the observed states. These assignments and the spectroscopic factors are compared with recent shell-model calculations. (auth)

16021 DISTRIBUTION OF RADIONUCLIDES FROM THE INTERACTION OF 3- AND 29-GeV PROTONS WITH SILVER. Katcoff, Seymour; Fickel, Harry R.; Wyttenbach, Armin (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 166: 1147-55 (Feb. 20, 1968). (BNL-11640).

Formation cross sections were measured of about 60 radionuclides isolated from Ag irradiated by 3- and 29-GeV protons. From these data, isobaric charge distributions and mass-yield curves were derived. At 3 GeV, the total isobaric cross sections are ~40 mb near the target, and they decrease to a broad minimum of 4 mb at around A = 30–40. For lighter products, the cross sections increase again. At 29 GeV, light- and intermediate-mass products (20 < A < 50) have 20 to 100% higher cross sections than at 3 GeV; the heavier products (A > 65) have 10–20% lower yields. Corresponding charge-distribution curves at the two energies are identical except for shifts in absolute magnitude. Comparison of the 3-GeV mass-yield curve with the results of a Monte Carlo calculation based on a cascade-evaporation model shows that such a mechanism can account for the observed cross sections down to about mass 50. The lower-mass products (15 < A < 35) must be formed mainly in a fragmentation or "fission-like" process. Comparisons are made with previous nuclear-emulsion and radiochemical results. (auth)

16022 K-CONVERSION COEFFICIENT OF 279 keV LEVEL IN ^{203}Tl. Sahota, H. S.; Ghumman, B. S.; Sood, B. S. (Punjab Univ., India). Curr. Sci. (India), 37: 42(Jan. 20, 1968).

A new method was developed to determine K-conversion coefficients. It depends on the measurement of the ratio of the intensities of the K-shell x-rays which follow internal conversion and the x-rays that are emitted when a target of suitable Z-value is irradiated with gamma rays competing with the internal conversions. A description is given of the use of the method to determine the K-conversion coefficient of the well-known 279-keV level in ^{203}Tl. (S.F.L.)

16023 STUDIES OF THE γ TRANSITIONS IN ^{221}Fr. Leang, Chin-Fan (Centre de Spectrometrie Nucleaire, Essonne, France). Compt. Rend., Ser. A and B, 265: 417-19(Aug. 16, 1967). (In French).

The γ transitions of ^{221}Fr were studied by the method of α-γ bidimensional coincidences between the α junction and Ge(Li) detector. The results obtained up to the present are tabulated. There is extreme disagreement with the results of Watstra with respect to the γ/α ratio, transition, and multipolarity. There is agreement on the γ energy. (J.S.R.)

16024 CONVERSION ELECTRONS AND MULTIPOLARITIES OF TRANSITIONS IN ^{110}Ag. Elze, Th. W.; Egidy, T. v.; Freund, H. U.; Dutta, B. C.; Kaiser, W. (Technische Hochschule, Munich). Z. Phys., 209: 497-510(1968). (In German).

The spectrum of internal conversion electrons emitted by ^{110}Ag after thermal-neutron capture was measured with the beta spectrometer at the research reactor near München. 45 conversion lines corresponding to 34 transitions were found between 0 and 300 keV. The multipolarities of 19 transitions were determined. The low-energy gamma radiation was investigated between 10 and 600 keV by means of a Ge(Li) detector. A partial level scheme containing the most intense transitions is proposed. (auth)

16025 THE BETA DECAY OF ^{134}Cs. Hsue, S. T.; Kim, M. U.; Langer, L. M.; Spejewski, E. H. (Indiana Univ., Bloomington). Nucl. Phys., A109: 423-32(1968).

A detailed investigation of the beta decay of ^{134}Cs was made by means of a magnetic spectrometer employing an energy selection technique which provides a high degree of discrimination against scattering and background. A careful analysis of the beta groups populating the 1401 and 1643 keV levels in ^{134}Ba reveals that each of them has an essentially statistical shape. The endpoint energies, intensities, and $\log_{10}$ft values for the five beta groups are: 89 keV (27 ± 2%, 6.4), 415 keV (3.0 ± 0.5%, 9.5), 658.0 ± 0.4 keV (70 ± 2%, 8.8), 891 keV (0.045 ± 0.015%, 11.7 ± 0.2), and 1454 keV (0.008 ± 0.004%, 13.3 ± 0.3). The Q_β value is 2058.5 ± 0.4 keV. (auth)

16026 EXPERIMENTS ON PARITY ADMIXTURE IN NUCLEAR STATES. Boehm, F.; Kankeleit, E. (California Inst. of Tech., Pasadena). Nucl. Phys., A109: 457-64(1968).

Parity admixtures in nuclear states in ^{175}Lu, ^{181}Ta, and ^{203}Tl were investigated by studying the circular polarization asymmetry of gamma rays from unpolarized sources. The following values were found for the degree of circular polarization in the three isotopes, respectively: $P = (+0.2 \pm 0.3) \times 10^{-4}$, $P = (-0.1 \pm 0.4) \times 10^{-4}$ and $P = (-0.2 \pm 0.3) \times 10^{-4}$. In ^{181}Ta, the quoted error represents the total error from internal and external consistency requirements, the latter contribution was found by including several recent sets of data. All values are consistent with estimates of the weak interaction contribution in nuclear forces. (auth)

16027 A Ω-FORBIDDEN TRANSITION IN ^{172}Tm. Hagemann, U.; Meiling, W.; Andreeff, A.; Kaestner, R.; Manfrass, P.; Stary, F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A109: 407-16(1968). (In German).

The lifetimes of levels in ^{172}Tm were measured as $T_{\frac{1}{2}}$(407 keV) = 1.07 ± 0.05 ns, $T_{\frac{1}{2}}$(535 keV) = 1.22 ± 0.05 ns and $T_{\frac{1}{2}}$(610 keV) ≦ 0.3 ns. The high hindrance factor (3.6×10^3) of the 407 keV transition can be explained by twice Ω-forbiddenness. (auth)

16028 STUDY OF K = ½ ROTATIONAL BAND LEVELS OF THE ODD ^{169}Tm AND ^{171}Tm NUCLEI. Begzhanov, R. B.; Sadykov, Kh. M.; Safarov, R. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 45-51(1967). (In Russian).

A number of the quantum characteristics of the excited states of ^{169}Tm and ^{171}Tm are considered. These nuclei are strongly deformed and have anomalous rotational bands with K = ½. The time characteristics of the energy levels were investigated by delayed coincidence counting of the beta and gamma transitions. The energy resolution of the transition is about 5 keV. Enriched Er is irradiated with thermal neutrons to produce Tm activities. The average half-life of the 5.1 keV level in ^{171}Tm was found to be 2.92×10^{-9} sec from beta-gamma and gamma-gamma coincidence counting. The half-life of the 425.1 keV level was found to be 2.63×10^{-6} sec. The half-life of the 8.4 keV level in ^{169}Tm was 5.12×10^{-9} sec. Calculated magnetic moment values ($\mu_{\frac{1}{2}}$, $\mu_{\frac{3}{2}}$, $\mu_{\frac{5}{2}}$, and $\mu_{\frac{7}{2}}$) and half-life values of these levels ($\tau_{\frac{1}{2}}$, $\tau_{\frac{3}{2}}$, and $\tau_{\frac{5}{2}}$) for ^{169}Tm and ^{171}Tm were compared with the experimental values. A large difference in half lives was observed for the level with I = 3/2. In this case E was decreased from 8.4 keV for ^{169}Tm to 5.1 keV for ^{171}Tm with a significant increase in the internal conversion coefficient α. Theoretical calculations of the moments of inertia of ^{169}Tm, ^{171}Tm, and ^{171}Yb were made on the basis of Nilsson's scheme with a residual interaction of the superconducting type being taken into account. (TTT)

16029 THE DECAY OF 9.7 min ^{125}Sn. Berzins, G. (Los Alamos Scientific Lab., N. Mex.); Auble, R. L. Nucl. Phys., A109: 316-28(1968).

The energy levels in ^{125}Sb that are populated in the decay of 9.7 min ^{125}Sn were studied by gamma-ray spectroscopy. High-resolution Ge(Li) detectors were used to record singles spectra, while coincidence data were obtained with a Ge(Li)-NaI(Tl) detector combination. The coincidence results coupled with energy sums and relative intensity considerations suggest the presence of excited states in ^{125}Sb at 332, 643, 921, 1350, 1484, 1701, 1736, 1914, and 1948 keV. The results are compared with previous decay scheme studies and (^{3}He, d) stripping measurements. (auth)

16030 THE PHOTONEUTRON CROSS SECTION OF ^{141}Pr. Cannington, P. H. (Univ. of Melbourne); Stewart, R. J. J.; Spicer, B. M.; Huber, M. G. Nucl. Phys., A109: 385-92(1968).

The photoneutron yield from ^{141}Pr was measured in 50 keV steps from threshold to 17 MeV by counting the annihilation γ-rays following position decay of ^{140}Pr. Leiss-Penfold analysis of the yield curves was used to derive the cross section. The results are compared with other recent measurements of the ^{141}Pr(γ,n)^{140}Pr cross section, and the results of a collective-model calculation which shows good agreement with the cross section obtained in this experiment are presented. (auth)

16031 THE DECAY OF ^{97}Nb. Graeffe, G.; Siivola, A. (Reactor Lab., Otaniemi, Finland). Nucl. Phys., A109: 380-4 (1968).

The decay of ^{97}Nb to the levels of ^{97}Mo has been studied by using a Ge(Li) detector, a NaI(Tl) scintillation detector and coincidence equipment. The following gamma transitions were observed: 658.1 ± 0.3 keV (100), 720.1 ± 0.7 keV (0.1 ± 0.03), 909.8 ± 1.0 keV

(0.06), 1022.2 ± 0.3 keV (1.2 ± 0.2), 1116.1 ± 1.0 keV (0.09 ± 0.03), 1267.9 ± 1.0 keV (0.11 ± 0.02), 1291.7 ± 1.0 keV (0.1 ± 0.03) and 1514 ± 1.5 keV (0.12 ± 0.03). These gamma transitions seem to depopulate corresponding excited states in ^{97}Mo. One more gamma ray at 856.0 ± 1.0 keV (0.06 ± 0.03) was seen; it is placed between the 1515 keV and 658 keV levels. (auth)

16032 THE DECAY OF ^{97}Zr. Siivola, A.; Graeffe, G. (Reactor Lab., Otaniemi, Finland). Nucl. Phys., A109: 369-79(1968).

The decay of ^{97}Zr to the levels of ^{97}Nb was studied with the aid of a Ge(Li) detector, an anti-Compton system, a NaI(Tl) scintillation detector and coincidence equipment. Gamma energies and relative intensities were determined. Excited states in ^{97}Nb were observed at 743, 1148, 1251, 1276, 1434, 1548, 1653, 1750, 1764, 1852, 2106, and 2247 keV. (auth)

16033 HALF-LIFE OF THE FIRST EXCITED STATE OF ^{125}Te. Hohenemser, C.; Rosner, R. (Brandeis Univ., Waltham, Mass.). Nucl. Phys., A109: 364-8(1968). (NYO-3823-2).

The half-life of the 35.3 keV first excited state of ^{125}Te was remeasured using the technique of delayed coincidences. It is shown that a prompt contribution to the delayed coincidence curve can be avoided for both the ^{125}I and ^{125}Sb parent. The result obtained from three different measurements is $T_{\frac{1}{2}}$ = 1.475 ± 0.010 nsec. (auth)

16034 SPIN VIBRATIONAL 1^+ STATES IN ^{208}Pb. Broglia, R. A. (Univ. of Copenhagen); Molinari, A.; Soerensen, B. Nucl. Phys., A109: 353-63(1968).

One-particle–one-hole 1^+ states are calculated in ^{208}Pb with both Tamm-Dancoff and random phase approximations using realistic forces. Form factors for inelastic electron scattering excitation are given. A discussion of the collectivity of the considered states based on the energy weighted M1 sum rule is reported. (auth)

16035 CORRECT USE OF CONSERVED VECTOR CURRENT THEORY IN FIRST-FORBIDDEN β-DECAY OF ^{170}Tm. Bogdan, D. Vata, I. (Institut for Atomic Physics, Bucharest). Nucl. Phys., A109: 347-52(1968).

It is shown that a correct use of the formula connecting the $\int\alpha$ and $\int$1r matrix elements clearly indicates that Woods–Saxon wave functions are most suitable to describe the β^--decay of the ^{170}Tm nucleus. (auth)

16036 ENERGY LEVELS IN ^{183}Re FROM THE ^{181}Ta(^{4}He, 2nγ) ^{183}Re REACTION. Newton, J. O. (Univ. of Manchester, Eng. Univ. of California, Berkeley). Nucl. Phys., A108: 353-81(1968).

Gamma rays and conversion electrons following the ^{181}Ta(^{4}He, 2nγ)^{183}Re reaction were studied with Ge(Li) detectors and with an electron spectrometer. Precise energy measurements and measurements on excitation functions, angular distributions, and gamma-gamma coincidences were performed. Evidence is given for rotational members of the $\frac{5}{2}^+$[402] ground state band and for the $\frac{5}{2}^-$[514] band up to $\frac{23}{2}^+$ and $\frac{21}{2}^-$, respectively. Both bands require a term of alternating sign when the energies of the states are expressed as power series in I(I + 1). The quality $(g_K - g_R)/Q_0$ was found to be constant up the bands within the experimental error. It is proposed that some gamma rays originate from the $\frac{9}{2}^-$, $\frac{13}{2}^-$, and $\frac{17}{2}^-$ states of the $\frac{1}{2}^-$[541] band. There is evidence that this band is strongly Coriolis mixed. (auth)

16037 MATRIX ELEMENT CANCELLATION IN THE BETA DECAY OF ^{141}Ce AND ^{199}Au. Beekhuis, H.; van Duinen, R. J. (Univ. Groningen, Netherlands). Nucl. Phys., A108: 382-400 (1968).

First-forbidden β-transitions in ^{141}Ce and ^{199}Au were investigated by means of shape and longitudinal polarization measurements. For ^{141}Ce the coefficients a' in the shape factor C'(W) = 1 + a'W are 435 keV branch: a' = −0.28 ± 0.03; 580 keV branch: a' = −0.28 ± 0.02; and for ^{199}Au 460 keV branch: a' = −0.24 ± 0.03. The degree of longitudinal polarization of 310 keV electrons in the decay of ^{199}Au is found to be P_L = (−0.84 ± 0.03)(v/c). All experiments agree with the predictions of the j-j coupling shell model and of the conserved vector current theory. However, the 435 keV beta branch of ^{141}Ce could only be fitted assuming the transition to be $f_{\frac{7}{2}}$ neutron to $d_{\frac{5}{2}}$ proton, which is in contradiction with a $g_{\frac{7}{2}}$ character of the 145 keV state. Under this assumption we find for the matrix element ratio Λ = 2.5 ± 0.1 and Λ = 2.58 ± 0.05 for the 435 keV and the 580 keV branches, respectively. In the case of ^{199}Au, where the polarization measurement was incorporated in the analysis, Λ = 2.62 ± 0.03 was found. (auth)

16038 ENERGY LEVELS IN SOME DOUBLY EVEN BARIUM ISOTOPES. Abdul-Malek, A.; Naumann, R. A. (Princeton Univ., N. J.). Nucl. Phys., A108: 401-24(1968).

The level schemes of ^{134}Ba and ^{132}Ba, which are populated in the decay of the corresponding lanthanum isotopes, were studied using magnetic, scintillation, and semiconductor spectrometers. Transitions previously incorrectly assigned as following the decay of ^{133}Ce were reassigned as following the decay of ^{132}Ce. A tentative level scheme of ^{132}La and a partial level scheme of ^{130}Ba are also presented. (auth)

16039 RELATIVE INTENSITY OF K-AUGER ELECTRONS FROM THULIUM. Gizon, J. (Univ. Grenoble, France. CEN, Grenoble, France). Nucl. Phys., A108: 425-33(1968). (In French).

The K-Auger spectrum of Tm(Z = 69) was studied by means of a double-focusing 50 cm radius β-spectrometer with a resolution of 0.1% for the $KL_{II}L_{III}$ line. The nine KLL lines were measured, their intensities are given, and are compared with theoretical values. The intensities of some KLX lines or groups were also measured. (auth)

16040 THE DECAY SCHEME OF ^{165}Tm. Kurcewicz, W.; Moroz, Z.; Preibisz, Z.; Schmidt Nielsen, B. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Phys., A108: 434-48(1968).

The electron-capture decay ^{165}Tm → ^{165}Er was investigated with the six-gap β-ray spectrometer as well as Ge(Li) and NaI(Tl) γ-ray detectors. The single γ-ray spectrum, e-γ and γ-γ coincidence spectra were studied. Some tentative levels were confirmed and several new ones established. The structure of the non-rotational states in ^{165}Er is discussed in terms of a model in which the interaction of quasi-particles with quadrupole and octupole phonons is considered. The energy spacing between states with a predominant single-particle character is compared with the energy spacing calculated on the basis of the pairing force theory. (auth)

16041 EXCITED STATES OF SLIGHTLY DEFORMED ODD NUCLEI. Begzhanov, R. B.; Isakov, B.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 60-9(1967). (In Russian).

Excited states of the quadrupole type in odd nuclei are a complex combination of single-particle, rotational, and oscillatory excitations. Coupling of the rotational and single-particle states with small longitudinal and radial oscillations of the nuclear surface are taken into account. The Schroedinger equation with its Hamiltonian operator is solved by successive approximations to give the energies of excited states for ^{185}Au, ^{101}Tc, ^{233}U, and ^{229}Th at various spins. The level energies of the main rotational–single-particle bands are of two types with increasing nonadiabaticity μ. Levels of the first type depend slightly on μ, and deform slightly with increasing μ. Values of $\cdot\mu$ can be determined from the energy ratio of two levels having the same parity. A number of excited states of odd nuclei which are considered to be single-particle by the usual interpretation are actually a complex combination of single-particle, rotational, and beta and gamma oscillatory excitations if the nonadiabaticity μ is taken into account. (TTT)

16042 BETA-GAMMA CASCADE ANGULAR-CORRELATION MEASUREMENTS IN ^{152}Sm. Row, K. S.; Sastry, D. L.; Jnananda, S. (Andhra Univ., Waltair, India). Nuovo Cim., (10) 53B: 114-19(Jan. 11, 1968).

The energy dependence of the beta-gamma angular correlation of the $\frac{5}{2}^- \xrightarrow{\beta^-} \frac{3}{2}^+ \xrightarrow{\gamma} \frac{1}{2}^+$ cascade in the decay of ^{152}Sm was measured in the beta energy range 210 to 630 keV with a fast-slow scintillation assembly. The integral correlation experiment was also conducted and the results showed that ϵ_2 was −0.04 ± 0.001 and ϵ_4 was −0.001 ± 0.012. The results of the differential correlation experiment were in accordance with the quasi-allowed approximation applicable to some first-forbidden beta transitions. (auth)

16043 RATIOS OF E2 TRANSITION PROBABILITIES OF DEFORMED EVEN-EVEN NUCLEI. Abecasis, S. M.; Bosch, H. E. (Instituto de Investigacion Aeronautica y Espanol, Buenos Aires). Nuovo Cim., (10) 53B: 147-54(Jan. 11, 1968).

Several ratios of E2 transition probabilities between levels belonging to the ground-state, beta- and gamma-rotational bands in deformed even-even nuclei are numerically calculated within the framework of the rotation-vibration interaction model. A detailed comparison of the theoretical predictions with available experimental data is performed. The conclusion can be drawn that this model gives at the present one of the best agreements with experiment without the introduction of empirically determined parameters. (auth)

16044 LOW-FLUX MEASUREMENT OF ^{235}U EPICADMIUM CAPTURE-TO-FISSION RATIO. Redman, W. C.; Bretscher, M. M. (Argonne National Lab., Ill.). Nucl. Sci. Eng., 31: 247-53(Feb. 1968).

A combination of relative reactivity measurements and absolute

counting techniques was applied to determine the epicadmium capture-to-fission ratio for ^{235}U. Significant features of this procedure are its requirement of only a moderate neutron flux, the application of ^{252}Cf and manganese to measure the relative importance of fission and absorbed neutrons, and the use of methods that differ from those applied in the high fluence procedures for α measurements. The resulting value of 0.519 ± 0.023, for infinite sample dilution, 1/E spectrum, and 0.5-eV low-energy cutoff, is in good agreement with recent results from high fluence irradiations and differential cross-section data. (auth)

16045 MEASUREMENT OF ^{135}I YIELD RATIOS AND FISSION-PRODUCT CROSS SECTIONS IN THE ADVANCED REACTIVITY MEASUREMENT FACILITIES. Nisle, R. G.; Stepan, I. E. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 31: 241-6(Feb. 1968).

The yields of ^{135}I in the fission of ^{233}U, ^{239}Pu, and ^{241}Pu relative to that of ^{235}U were measured by an integral method using the Advanced Reactivity Measurement Facilities (ARMF I and II). The xenon reactivity transient was measured following irradiation of the fissile isotope in the Materials Testing Reactor (MTR) for periods from 2.5 to 16 days. The use of the two ARMF reactors permits the calculation of the absorption cross sections of both simple absorbers and fissile atoms. The ^{135}I yield ratios, relative to ^{235}U, were found to be 0.825 ± 0.072 for ^{233}U, 1.006 ± 0.067 for ^{239}Pu, and 1.221 ± 0.089 for ^{241}Pu. The uncertainties quoted are confidence intervals at the 90% confidence level. (auth)

16046 STUDY OF FISSION-NEUTRON SPECTRA WITH HIGH-ENERGY ACTIVATION DETECTORS. PART II. FISSION SPECTRA. Grundl, James A. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 31: 191-206(Feb. 1968).

The energy spectra of neutrons from the thermal-neutron-induced fission of ^{235}U, ^{233}U, and ^{239}Pu were compared by means of eight activation detectors that cover the energy range 0.8 to 16 MeV. The detectors are exposed to fission neutrons produced at the center of a 10-cm-diam spherical cavity within a heavy-water moderator. Comparison of detector responses for the three spectra yield average energy ratios, $^{235}U : ^{233}U : ^{239}Pu = 1 : 1.021 \pm 0.005 : 1.039 \pm 0.002$. Differences between the normalized spectra are most pronounced at high energies as exemplified by the relative $^{239}Pu : ^{235}U$ flux ratios 1.17 for $6 < E < 11$ MeV and 1.35 for $E > 11$ MeV. Spectral indexes for the ^{235}U fission spectrum, based on measurements with monoenergetic neutrons, show progressively fewer neutrons above 6 MeV than given by the usual Maxwellian description of the fission spectrum, $\chi_{^{235}U}(E) = (0.770)E^{\frac{1}{2}} \exp(-0.775E)$. At lower energies, the observed spectral indexes involving the ^{235}U, Np, and ^{239}U fission detectors are significantly discrepant with those predicted. (auth)

16047 SEARCH FOR A HIGH SPIN THREE-QUASIPARTICLE STATE IN ^{179}Ta. Alexander, Peter; Ryde, Hans (California Inst. of Tech., Pasadena. Brookhaven National Lab., Upton, N. Y. Isotopes, Inc., Westwood, N. J.). Ark. Fys., 35: 357-9 (1967). (CALT-63-47).

A search for the expected high-spin three-quasiparticle isomer in ^{179}Ta was performed. From the negative result of this search, it is concluded that the half-life of the isomer most probably is either shorter than 15 min or longer than 15 days. (auth)

16048 THE NEUTRON RESONANCE PARAMETERS AND AVERAGE CAPTURE CROSS SECTION OF ^{165}Ho. Asghar, M.; Chaffey, C. M.; Moxon, M. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A108: 535-46(1968).

Neutron resonance scattering and capture measurements were made on $^{165}Ho(I = 7/2)$ using a variety of sample thicknesses. On the basis of a χ^2 test, the spins of eight resonances were assigned and five more given tentative spin assignments. An additional six resonances were given tentative spin assignments on the assumption that the Γ_γ does not fluctuate significantly from resonance to resonance. The results are compared with the assignments of other workers. The values of total radiation widths Γ_γ do not show any significant fluctuations from the weighted mean value of 75.7 ± 2.4 MeV. The measurements of the average capture cross section from 0.5 keV to 100 keV are given, and these data are respectively lower than the published values of capture cross section (at 30 keV and 60 keV) obtained with a liquid scintillation tank and higher than the value (at 24 keV) obtained using an activation method. However, the data are in very good agreement with the Russian data obtained using the lead slowing down neutron spectrometer. (auth)

16049 ENERGY OF ^{242}Am AND ^{242m}Am FISSION FRAGMENTS. Erkkila, B. H.; Leachmann, R. B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A108: 689-96(1968). (LA-DC-8918).

The energy spectra of single fragments from spontaneous fission of the 14 msec ^{242m}Am isomer and from prompt fission of ^{242}Am were measured. The isomer was produced by the $^{242}Pu(d,2n)^{242m}Am$ reaction, and the prompt fissions were produced by the $^{240}Pu(d,f)$ reaction. The fragments from delayed fission were observed by semiconductor detectors after the compound nucleus had recoiled to a rotating catcher wheel. The usual doubly peaked spectra of fragment energies from heavy element fission were observed in both cases. The valley of the spectrum from spontaneous fission of the isomer is equally deep as the valley of the spectrum from prompt fission induced by 12 MeV deuterons. Energies of the peaks were the same for prompt fission and for spontaneous fission of the isomer. The former energies were constant over the 7.6 to 14 MeV span of incident deuteron energy. Comparisons of these fragment energies with those from ^{252}Cf spontaneous fission and from deuteron-induced fission of other heavy elements agree with $Z^2/A^{\frac{1}{3}}$ systematics. (auth)

16050 THE DECAY OF THE K = 3 ROTATIONAL BAND OF ^{172}Yb BASED ON THE 1172.3 keV STATE. Kaye, Geoffrey (Chalk River Nuclear Labs., Ont.). Nucl. Phys., A108: 625-40(1968).

The γ-ray transitions from the K = 3 rotational band based on the 1172.3 keV state were investigated using the Chalk River high-resolution β-ray spectrometer (resolution settings 0.2% and 0.06%) germanium lithium-drifted γ-ray counters and e-γ delayed coincidence techniques. From L conversion-electron subshell intensity ratios, the multipolarities of the following transitions were deduced: 78.74 keV (E2), 90.64 keV (26 ± 3% M1 + 74 ± 3% E2), 112.76 keV (33 ± 5% M1 + 67 ± 5% E2), 134.35 keV (33 ± 12% M1 + 67 ± 12% E2), 181.51 keV (E2), 203.43 keV (E2), 247.14 keV) (E2) and from conversion coefficient measurements, 810.0 keV (M1), 900.7 keV (M1), 912.1 keV (18 ± 12% M1 + 82 ± 12% E2), 929.0 keV (63 ± 16% M1 + 37 ± 16% E2) 1002.6 keV (12 ± 11% M1 + 88 ± 11% E2) and 1093.5 keV (E2). The half-lives of the following states were measured: 78.74 keV 1.6 ± 0.4 nsec, 1172.3 keV 7.8 ± 0.4 nsec and 1262.9 keV ($\leq$0.6 nsec). (auth)

16051 ISOMER RATIOS AND CROSS SECTIONS FOR THE ISOMERIC PAIR ^{120g}Sb AND ^{120m}Sb IN THE $^{121}Sb(n,2n)$ REACTION. Kanda, Yukinori (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 24: 17-22(Jan. 1968).

Cross-section ratios and excitation functions for the isomeric pair ^{120g}Sb and ^{120m}Sb produced by the $^{121}Sb(n,2n)$ reaction were measured in the energy range 13 to 15 MeV. The experimental isomer ratios are compared with those calculated by means of the Fermi gas and superconductor models. The superconductor model seems to be valid. In a different way, the calculated values based on the Fermi gas model agree with experiments if the moment of inertia is taken to be 0.60 times the rigid-body value. (auth)

16052 ISOTOPIC VARIATION OF NUCLEAR DIMENSIONS DEDUCED FROM PHASE-SHIFT PARAMETERS OF ELASTIC SCATTERING OF α PARTICLES AT 44 MeV. Faivre, J. C.; Krivine, H.; Papiau, A. M. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A108: 508-18(1968). (In French).

Phase-shift analysis of α-particle elastic scattering on 32 isotopically separated targets between A = 12 and A = 124 was used to obtain detailed information on nuclear radii R and surface thickness of a neighboring nuclei assuming a spherical shape with diffuse edge. The general trend is in agreement with $R = 1.52\ A^{\frac{1}{3}}$ and a = 0.36 fm; but, as already observed in other types of experiments, there are systematic disagreements with the general law for the local variations of R with A. It is found that small variations of a are proportional to those of R within each major shell. These deviations to the general law show the influence of microscopic structure of ground states and should be connected with variations of nucleon densities in nuclei. (auth)

16053 INTEGRAL AND DIFFERENTIAL CROSS SECTIONS OF ^{232}Th FISSION BY NEUTRONS. Ermagambetov, S. B.; Smirenkina, L. D.; Smirenkin, G. N. 18p. (In Russian). (CONF-661014-51). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The energy dependence of the fission cross section $\sigma_f(E_n)$ usually shows a complex structure in odd fissionable nuclei near the threshold. Characteristics of the lower fission channels can be derived by comparing the observed fission cross section σ_f and the angular distributions of the fission products with the theoretical values. Then the characteristics of the lower fission channels are selected in such a way as to obtain agreement between the calculated and experimental values. Such an analysis led to the following succession of lower channels of the transitory ^{233}Th nucleus, which were excited in the ^{232}Th (n,f) reaction by neutrons having an energy $E_n < 1.6$ MeV: $\frac{1}{2}^+$, $\frac{3}{2}^-$, and $\frac{3}{2}^+$. The new channels with $K = \frac{1}{2}$ explain the inflexion of σ_f in the region of neutron energy $E_n \cong 1.1$ MeV. (TTT)

Nuclear Theory

Refer also to abstracts 14788, 15554, 15560, 15720, 15951, 15952, 15957, 15989, 16013, 16041, and 16043.

16054 (BMwF-FBK-67-80) UNTERSUCHUNGEN ZUR BESTIMMUNG VON KERNMOMENTEN STABILER ATOMKERNE MIT HILFE DER ATOMSTRAHLRESONANZMETHODE. (Measurements of Nuclear Moments of Stable Nuclei With the Atomic Beam Magnetic Resonance Method). Penselin, S. (Bonn Univ. (West Germany). Institut fuer Angewandte Physik). Sept. 1967. 21p. (In German). Dep.

Improvements on two atomic-beam magnetic-resonance devices are outlined, and the results of measurements of the magnetic dipole moments of ^{63}Cu, ^{65}Cu, ^{165}Ho, and ^{87}Rb are presented. A measurement of the hyperfine structure in ^{175}Lu is also summarized. (D.C.W.)

16055 (ITF-67-15) PARTICLE IN NUCLEAR-COULOMB FIELD (SPECTRAL PROBLEMS). Mentkovskii, Yu. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 104p. Dep.

An analytic approach to the theory of charged-particle motion in Coulomb fields is presented in which the problems concerning the energy spectrum, the completeness of the set of physical solutions to the Schroedinger equation, and other spectral problems are solved on the basis of the theory of functions of a complex variable. (D.C.W.)

16056 (JINR-P7-3657) NEKOTORYE ZAMECHANIYA OB IDENTIFIKATSII PRODUKTOV REAKTSII (H,I.,xn) PO KRIVYM VOZBUZHDENIYA. (A Comment on the Identification of (H,I.,xn) Reaction Products From Excitation Functions). Noibert, V.; Aleksander, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 13p. (In Russian). Dep.

Various possibilities for determining the mass number of (H. I.,xn) reaction products from excitation functions are investigated. On the basis of 58 well-established excitation functions, the applicability of Alexander and Simonoff's empirical relation is checked. Using a simple statistical model of neutron evaporation including the effect of nuclear rotation, the average kinetic energy and number of evaporated neutrons are calculated. In most cases a fair agreement between experimental and calculated values is obtained. (auth)

16057 (JUL-CONF-1(Suppl.), Paper 2) NIEDERENERGIE KERNSPALTUNG. (Low-Energy Nuclear Fission). Suessmann, G. (Frankfurt Univ. (West Germany). Institut fuer Theoretische Physik). 16p. (In German).

A bibliographic reviewed is given of the principal models of low energy nuclear fission. The cluster model, the phenomenological drop model, the Fermi drop model, and the adiabatic model are discussed. (J.S.R.)

16058 (MATSCIENCE-57) LECTURES ON NUCLEAR MODELS AND NUCLEAR MATTER. Rao, K. Srinivasa; Sridhar, R. (Institute of Mathematical Sciences, Madras (India)). [1967]. 202p. Dep.

Lectures dealing with the classification of nuclear models, the liquid-drop model, the shell model, the optical model, the unified model, and nuclear reactions are included as are lectures dealing with various aspects of the theory of nuclear reactions such as time-dependent and -independent perturbation methods, the second-quantization approach to the many-body problem, the Hartree-Fock method, the Brueckner theory, and the Moszkowski and Scott separation method. (D.C.W.)

16059 (ORNL-4220) NCDATA: NUCLEAR COLLISION DATA FOR NUCLEON-NUCLEUS COLLISIONS IN THE ENERGY RANGE 25 TO 400 MeV. Alsmiller, R. G. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 29p. Dep. CFSTI.

A computer code written in FORTRAN IV is described which interpolates between analytic fits to intranuclear-cascade data and gives for either neutrons or protons, in the energy range 25 to 400 MeV, incident on a nucleus of atomic weight A (between 12 and 238): the nonelastic cross section as a function of energy; the cascade neutron and proton emission spectra in the angular intervals 0 to 30°, 30 to 60°, 60 to 90°, and 90 to 180°; the evaporation neutron and proton emission spectra (assumed isotropic); and the cascade neutron- and proton-emission spectra integrated over all angles. In addition to numerical values for each of these quantities, the code also gives the values of the coefficients that occur in an analytic expression for each of these quantities. (auth)

16060 (RHEL/R-153) MULTIPLE SCATTERING CORRECTION TO THE AVERAGE ENERGY LOSS OF HEAVY PARTICLES. Tschalaer, C.; Bichsel, H. (Rutherford High Energy Lab., Chilton (England)). Oct. 1967. 40p. Dep. CFSTI. UK 6s. 0d.

The mean increase in energy loss $\delta\overline{T_m}$ due to multiple scattering of heavy particles is treated for thick absorbers. Using Molière's theory with the improvement by Nigal et al., the mean square and mean fourth power of the reduced scattering angle is calculated for all absorber materials, for incident energies larger than a few MeV, for energy losses up to 80% of the incident energy, and for circular detectors with angles of acceptance up to ±35 degrees. A method is given for computing the mean energy correction $\delta\overline{T_m}$ from the incident and outgoing energies, from the stopping power in the absorber, and from the detector angle of acceptance. A typical value for $\delta\overline{T_m}$ of 649 keV is obtained for 40 MeV protons losing 32 MeV in a gold absorber and being seen under a detector angle of ±29 degrees. (auth)

16061 DETERMINATION OF ABSOLUTE DISINTEGRATION RATES BY COINCIDENCE METHODS. Remsberg, L. P. (Brookhaven National Lab., Upton, N. Y.). Annu. Rev. Nucl. Sci., 17: 347-72(1967).

The use of $\gamma-\gamma$ and $\beta-\gamma$, including $4\pi\beta-\gamma$, coincidence methods for determining absolute disintegration rates of radioactive nuclides is reviewed. Much of the article is concerned with the calculation, determination, or elimination of correction terms involved in coincidence counting measurements. (S.F.L.)

16062 ENERGY LEVELS OF NUCLEI WITH A = 14. Mamasakhlisov, V. I.; Vashakidze, I. Sh. (Tbilisi State Univ., USSR). Soobshch, Akad. Nauk Gruz. SSR, 48: 37-44(1967). (In Russian).

Nuclear levels and radiative transitions in A = 14 nuclei were studied on the basis on the non-local factorization potential. The lower excitation levels of the A = 14 nuclei were calculated using the central symmetry Hartree-Fock method. The experimental data for exciting states of A = 14 nuclei starting with the ground state of the ^{12}C nucleus are presented graphically and the energy of independent nucleons in the ^{12}C nuclei measured starting with the ground state of the ^{12}C nucleus was tabulated. (R.V.J.)

16063 NUCLEAR RADIUS, PROTON CONTENT, ELECTRON SCATTERING, CHARGE DENSITY, MAGIC NUMBERS, AND BORN-APPROXIMATION MODIFICATION. Dutta, A. K. (Calcutta Univ.). Indian J. Phys., 41: 538-44(July 1967).

The rms radii of nuclei with z protons are determined closely in terms of $E_B^0(A)$, the binding energy per nucleon without Coulomb and asymmetry energies. Probing from the other side, it is observed that the form factor F(q) for light or heavy nuclei, determined from experimental $\sigma(\theta)$ values for high-energy electrons (Hahn et al., 1956) and point charge scattering $\sigma_M(\theta)$, can be represented by a simple relation, superposed with small fluctuations. With the help of Born's approximation, the F(q) relation is transformed into an expression for ρ, which gives a simple relation for the rms radii of nuclei which is consistent with that in terms of E_B^0. The expression for ρ, dictated by form-factor data and Born's approximation, requires a normalizing factor N, whose reciprocal must necessarily measure the factor to be associated with Born's approximation when applied to nuclei. The fluctuations superposed on the basic relation for the form factor give rise to variations of charge density with maxima at proton numbers which are magic numbers. The relations determining basic nuclear characteristics can all be expressed in terms of E_B^0. (auth)

16064 REARRANGEMENT COLLISIONS FOR HIGH ENERGIES (LINEAR MODEL). Dettmann, K.; Leibfried, G. (Technische Hochschule, Aachen). Z. Phys., 210: 43-59(1968).

The high-energy behavior of the cross section for particle exchange in a three-particle collision is investigated for arbitrary masses and a rather general class of potentials. For convenience, a linear model is used. It is shown that in general the first and second Born approximations provide the leading terms for high energies. If the exchanged mass is "small," the interaction between the two heavy masses cancels. The wave treatment and the impact-parameter version give identical results. For particular mass ratios, either the first or the second Born approximation provides the leading term. Then even backscattering can be dominant. The high-energy results agree with the asymptotic expansion for two exactly solvable cases. (auth)

16065 COUPLING OF A QUASIPARTICLE TO THE PAIRING VIBRATIONS. Cusson, R. Y.; Hara, K. (Univ., Heidelberg). Z. Phys., 209: 428-39(1968).

The intermediate coupling model of odd nuclei, where a nucleon is coupled to the surface vibration of an even system, has been successfully used in explaining various nuclear properties. It is pointed out that a similar picture is applicable to improve the BCS approximation for seniority-one states in the pairing force model by considering coupling of a quasiparticle to the pairing normal modes. It is shown that this model is, in part, equivalent to the

variational approach which takes the blocking effect into account. Several models are compared numerically. (auth)

16066 COMPUTER PROGRAM FOR ANALYSIS OF INELASTIC ELECTRON SCATTERING FROM NUCLEI. Tuan, S. T. (Duke Univ., Durham, N. C.); Wright, L. E.; Onley, D. S. Nucl. Instrum. Methods, 60: 70-6(Feb. 1968).

A partial wave analysis of inelastic electron scattering is carried out for electric and magnetic multipole excitations of the nucleus. The results of this analysis which includes the effects of energy loss and Coulomb retardation have been programmed for the computer. The resulting FORTRAN IV program is capable of calculating inelastic electron scattering differential and total cross sections for a large range of incident electron energies and transitions of multipolarity 1 to 5. The methods of calculation and the limitations of the program are discussed in some detail. (auth)

16067 NUCLEAR ORBITAL-REARRANGEMENT ENERGY. Meldner, H. (Univ. of California, Berkeley). Nuovo Cim., (10) 53B: 195-7(Jan. 11, 1968). (UCRL-17782).

It is a common procedure to interpret the spectra of nucleon transfer reactions in terms of energy eigenvalues in static Woods–Saxon or oscillator potentials. The corresponding wave functions are good enough to allow reasonable estimates of spin assignments (via DWBA calculations with adjusted energies). Agreement with the spectra is of questionable significance since mass differences can be compared quantitatively with the energy eigenvalues in a given well only if further simplifications are possible. For example, one must assume that orbital rearrangement energies are small compared to the observed mass difference. It is shown that these rearrangement energies can be large and can be quite different for different orbitals. On the basis of self-consistent calculations they are estimated to be comparable to level differences in nuclear potential wells. It is therefore an unjustified simplification to identify such level spacings with the mass difference observed, e.g., in nucleon transfer reactions. (S.F.L.)

16068 USE OF RESONANT STATES IN EIGENFUNCTION EXPANSIONS OF SCATTERING AND REACTION AMPLITUDES. Berggren, Tore (Lund Inst. of Tech., Sweden). Nucl. Phys., A109: 265-87(1968).

The orthogonality and completeness properties of the resonant states as defined by Humblet and Rosenfeld are investigated using a simple regularization method first suggested by Zel'dovich. It is found that at least for finite-range potentials, the set of bound states and any finite number of proper resonant states can be completed by a set of continuum states. This makes it possible to expand the scattering and reaction amplitudes in such a way that their resonance behaviour is exhibited, and the dependence of the corresponding partial widths on the interaction becomes more explicit. (auth)

16069 DISTRIBUTION LAWS FOR THE ROOTS OF A RANDOM ANTISYMMETRIC HERMITIAN MATRIX. Mehta, M. L.; Rosenzweig, N. (Argonne National Lab., Ill.). Nucl. Phys., A109: 449-56(1968).

In conjunction with the study of the perturbations of the statistical properties of nuclear spectra produced by interactions which are odd under time reversal, it was found that the case in which the odd part is very large can be treated analytically. While of no immediate physical interest, the precise results obtained serve as a check on the adequacy of the Monte-Carlo calculations reported in the preceding paper. With the help of the theory of random matrices, analytical results are obtained for the distribution of widths, the level density, two-level cluster function and the distribution of the spacing between adjacent energy levels. (auth)

16070 PERTURBATION OF THE STATISTICAL PROPERTIES OF NUCLEAR STATES AND TRANSITIONS BY INTERACTIONS THAT ARE ODD UNDER TIME REVERSAL. Rosenzweig, N.; Monahan, J. E.; Mehta, M. L. (Argonne National Lab., Ill.). Nucl. Phys., A109: 437-48(1968).

It is found that a rather small time-reversal-odd part in the nuclear Hamiltonian would produce an appreciable perturbation in the Porter–Thomas distribution of widths and also in the distribution of the spacings between energy levels. A comparison between the experimentally determined variances for some published neutron widths and partial radiation widths and the calculated variance allows one to place an upper limit on the magnitude of the time-reversal-odd part. The shift of the spacing distribution is particularly large on a percentage basis in the region of small spacings. As a measure of the time-reversal-odd part of the wave function, the overlap $|(\psi, T\psi)|$ was evaluated. All conclusions are based on a Monte-Carlo calculation with random Hermitian matrices having a small imaginary part. (auth)

16071 REMARK ON NUCLEAR HOLE STATES IN QUASI-FREE SCATTERING. Herscovitz, Victoria E.; Jacob, Gerhard; Maris, Th. A. J. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Nucl. Phys., A109: 478-80(1968).

Without adding basic complications, an improvement in the usual approximation of the overlap integral occurring in the cross section for quasi-free scattering is achieved by replacing the single-particle state by a hole state bound in a complex potential. The effect of the finite lifetime of hole states on the angular correlation distributions is estimated. (auth)

16072 ANALOGUE STATE (p,n) REACTIONS AT 94 MeV. Thurlow, Nola (Nuclear Physics Lab., Oxford). Nucl. Phys., A109: 471-7(1968).

The results of an analysis of (p,n) reactions at 94 MeV between isobaric analog states on a range of nuclei are presented. The method of analysis assumes the existence of the isospin term in the optical potential and it is found that this term is energy-dependent and peaked at the nuclear surface. (auth)

16073 ANGULAR DISTRIBUTION OF ELASTICALLY SCATTERED IONS WITH INELASTICITY BEING TAKEN INTO ACCOUNT. Khalikova, D. Kh.; Yakovlev, L. G. (Samarkand Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 77-8(1967). (In Russian).

The results of calculating the angular distribution of elastically scattered He^+ from He are given within the framework of optical scattering theory, that is, with inelasticity being taken into account. The calculation, which uses a Leonard–Wood potential with polarization being taken into account, gives the phase shift in the quasi-classical approximation. The cross-section for inelastic collision enters the calculation. The Born approximation is used at small angles. The calculated cross-section decreases more rapidly with increasing angle than the experimental value. The deviation can be explained by the choice of potential or by not taking into account charge transfer which proceeds in the same way as elastic scattering. (TTT)

16074 CALCULATING THE COEFFICIENT OF NONADIABATICITY OF ROTATION WITHIN THE FRAMEWORK OF THE SUPERFLUID MODEL. Safarov, R. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 78-9(1967). (In Russian).

The experimental deviations of a rotating nucleus from a simple rotator can be corrected by introducing an additional parameter, the nonadiabaticity of rotation which has a different functional dependence on the angular moment. The rotational band is described by the simple expression: $E_I = (1/C_1)[J^2 + C_1 I(I+1) - J]^{0.5}$. Here J is the moment of inertia and C_1 is the coefficient of nonadiabaticity. An expression is given for calculating the part of the coefficient of nonadiabaticity due to Coriolis anticoupling. From the results of calculating the coefficients of nonadiabaticity for ^{160}Dy, ^{170}Yb, and ^{172}Hf it follows that the Coriolis anticoupling contribution is less than half of the total value. An increase of this contribution on the borders of the deformation region is not observed. Apparently it is important in this case to take into account the centrifugal elongation in nuclear shape. (TTT)

16075 DENSITY MATRIX APPROACH TO THE ATOMIC NUCLEI: ANOMALOUS E1 TRANSITIONS, PARA- AND ORTHO-STATES, ISOBARIC ANALOGUE STATES. Birbrair, B. L. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys., A108: 449-77(1968).

The matrix elements of single-particle and collective transitions are expressed in terms of time-even ρ^+ and time-odd ρ^- components of a density matrix variation in the external field. ρ^+ and ρ^- obey a rather simple system, which has the same mathematical form in super-fluid and non-superfluid nuclei. The importance of the energy gap variation in the external field for the electric single-particle transitions is demonstrated. In particular the anomalous E1 transitions in deformed nuclei cannot be explained without taking into account the energy gap variation processes. A striking analogy exists between collective nuclear states and the hydrogen molecule. It is shown that the former can be characterized, to a good accuracy, by values of the intrinsic spin of either 0 or 1. Some experiments capable of displaying nuclear orthostates are proposed. The collective state equations are solved exactly analytically in the case of isobaric analog states. The nuclear Coulomb potential is accounted for explicitly and no approximations are made for the nuclear self-consistent field and the residual interaction. In this way we have obtained an exact formula for the allowed Fermi β-decay matrix element which accounts for all the isobaric spin impurities due to the nuclear Coulomb potential. Formulas for the ground-state isobaric spin impurity and the Coulomb shift were also derived. For the sake of completeness a method for exclusion of spurious states is

developed. It is applicable for any nuclear self-consistent potential and residual interaction radial dependences. (auth)

16076 ELECTRON SCATTERING AND THE SPECTROSCOPY OF PSEUDO-NUCLEI. Trainor, L. E. H.; Gupta, Raj K. (Univ. of Toronto). Nucl. Phys., A108: 257-73(1968).

The method of Cohen, Lawson, and Soper of comparing a shell-model study and an exact calculation for a two-level model (d- and f-states) is extended to the s-d shell and to the nondegenerate case. In contrast to the case of d-f states, concealed configuration interactions cannot easily occur in the s-d shell. It is shown that inelastic electron scattering provides, in principle, a sensitive test for the purity of the configurations occurring in a shell-model analysis of experimental results. (auth)

16077 MUON CAPTURE BY COMPLEX NUCLEI. Devanathan, V. (Univ. of Madras). pp 103-11 of Symposia on Theoretical Physics. Volume 4. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1967.

From 3rd Conference on Theoretical Physics, Madras, India. See CONF-650123-Vol.4).

The theory of meson (μ) capture by complex nuclei is outlined, and includes the precise form of the capture interaction, the determination of coupling constants, and the details of nuclear structure. The problem studied is treated in most general terms without restricting the discussion to any particular nucleus. Starting with the effective Hamiltonian of Fujii and Primakoff the capture rate is deduced using the shell model for the nucleus. This involves the summing and averaging over the leptonic and nuclear spin states. A study of the polarization of the outgoing nucleon in the process $\mu^- + X \rightarrow Y + N + \nu$ is made since it is unaffected by the nuclear wave function. (J.F.P.)

16078 PRECOMPOUND AND COMPOUND PARTICLES OF DECAY IN (n,p) REACTIONS. Kondaiah, E.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Nuovo Cim., (10) 53B: 174-9(Jan. 11, 1968).

A few (n,p) reaction spectra were analyzed using the expressions given by Griffin based on "exciton" model. Evidence in favor of precompound particles of decay leading to low excitation of residual nuclei and emitted at forward angles is obtained. (auth)

16079 VEGAS: A MONTE CARLO SIMULATION OF INTRANUCLEAR CASCADES. Chen, K.; Fraenkel, Z.; Friedlander, G.; Grover, J. R.; Miller, J. M.; Shimamoto, Y. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). Phys. Rev., 166: 949-67(Feb. 20, 1968). (BNL-11653).

The model dependence of the Monte Carlo simulation of intranuclear cascades generated by nucleons up to ~380 MeV incident on complex nuclei was investigated. Differences in the details of the Monte Carlo procedure between this work and previous intranuclear-cascade calculations are discussed. The specific effects that were investigated are those attendant upon the introduction of refraction of cascade particles when going through regions of varying potential energy, and upon the change in the nuclear density distribution from that of a uniform-density sphere to one with a diffuse surface similar to that consistent with electron-scattering experiments. Among the calculated quantities discussed are reaction cross sections, excitation energies of cascade products, spallation cross sections, energy and angular distributions of emitted particles, and linear and angular momentum transfers. The introduction of the diffuse-surface-density distribution improves agreement with available experimental data. At incident energies below ~200 MeV and for medium and heavy nuclei, best agreement with expermental data is obtained when refraction and reflection are neglected. Possible reasons for this result are discussed. (auth)

16080 INTRINSIC MATRIX ELEMENTS IN THE s-d SHELL. Abulaffio, Carla (Israel Inst. of Tech., Haifa). Phys. Rev., 166: 974-6(Feb. 20, 1968).

A new table of the intrinsic matrix elements of a two-body scalar Hamiltonian independent of spin is presented. The space spanned is that subspace of the s-d shell which contains the more deformed intrinsic states. The table is shown to be especially useful for the study of the relative position of bands belonging to the same SU(3) representation. (auth)

16081 NONADIABATICITY OF BETA-VIBRATIONS IN THE DAVYDOV MODEL. Plastino, A. (Univ. Nacional de La Plata, Buenos Aires); Abecasis, S. M.; Bosch, H. E. Nuovo Cim. (10), 51B: 566-7(Oct. 11, 1967).

The nonadiabaticity of beta vibrations in the Davydov model was studied for even-even rare earth nuclei in the range $60 \leq Z \leq 76$ and $90 \leq N \leq 114$. Results indicate that the energy spectra of these nuclei cannot be consistently fitted with the restricted formula given by Davydov. This fact is interpreted to mean that an adiabatic treatment of beta vibrations within the framework of the Davydov model cannot be made, at least in principle, for any nucleus. (S.F.L.)

16082 INELASTIC SCATTERING OF ALPHA PARTICLES, A TOOL FOR INVESTIGATION OF NUCLEAR STRUCTURE. Budzanowski, Andrzej (Univ. of Jagellonian, Krakow. Inst. of Nuclear Physics, Krakow). Postepy Fiz., 18: 645-61(1967). (In Polish).

Problems of the inelastic scattering of alpha particles on atomic nuclei are discussed. Special emphasis is put on the application of the inelastic scattering reactions proceeding via direct reaction mechanism for investigations of the structure of excited nuclear states. The selective properties of these reactions for excitation of collective degrees of freedom are explained in terms of the particle-hole model. Several versions of the adiabatic approximation, e.g., sharp cut-off diffraction model, smooth cut-off diffraction model, the Austern-Blair model, are described; and its usefulness for the determination of spins and parities of nuclear states is indicated. (auth)

16083 RECENT DEVELOPMENTS IN THE THEORY OF NUCLEAR MATTER. Dabrowski, Janusz (Univ. of Warsaw). Postepy Fiz., 18: 631-43(1967). (In Polish).

Since the successful nuclear matter calculations of Brueckner and Gammel in 1958, the situation of the theory for some time became less satisfactory for two reasons. First, calculations with the more up to date nuclear forces produced a value of the binding energy per nucleon, $-E/A$, smaller than the empirical value. Second, a careful treatment of the single-particle potential energies of excited states, initiated by Bethe, produced a further reduction in $-E/A$. The second difficulty has been resolved by Bethe, who included into the theory all the three-body diagrams. The series of these diagrams can be summed by an integral equation due to Faddeev. The single-particle potential energies are thereby reduced essentially to zero, and $-E/A$ is increased correspondingly. Thus only the first difficulty remains which, however, can be overcome by applying nuclear forces with a soft repulsive core. Recent calculations of $-E/A$ bring its value again into agreement with the experiment. (auth)

16084 SIMPLIFIED METHOD FOR KINEMATIC CALCULATIONS OF NUCLEAR REACTIONS. Winter, J. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods, 59: 167-9(Feb. 1968).

A simplified method of presentation of kinematic relationships in nuclear reactions is given. It allows to obtain in a convenient way the energy of the reaction products as a function of the angle of emission in the laboratory frame for nonrelativistic reactions. (auth)

16085 ASSOCIATION STUDIES OF ^{4}He EMISSION IN NUCLEAR SPALLATION. Toktarov, K. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 3-8(Mar.-Apr. 1967). (In Russian).

The continuous formation and breakdown of nucleon complexes is assumed in testing a theoretical model for the spatial structure of the nucleus. The wave function of ^{4}He, according to Bethe is written; and a formula is given for the probability of an intermediate state, where the system of nucleons is compressed to a size R. Values of R were estimated for the nuclei ^{16}O, ^{79}Br, and ^{107}Ag. The calculated values for the cross section of formation of alpha particles were too small in comparison with the experimental values. It is believed that the emission of high-energy alpha particles can occur by other mechanisms as well. (TTT)

16086 SPIN-ORBIT SPLITTING IN THE CONVENTIONAL SPHERICAL HARTREE-FOCK THEORY. Wong, Chun Wa (Oxford Univ.). Nucl. Phys., A108: 481-92(1968).

The single-particle spin-orbit splitting is calculated in the conventional spherical reaction-matrix Hartree-Fock theory using empirical nuclear sizes and harmonic oscillator wave functions. The contribution from spin-saturated shells and subshells is found to be only about half to two-thirds of the experimental value for a range of nuclei. The contribution from the incomplete (i.e., spin unsaturated) subshells is found to be large but has the wrong sign and a somewhat different radial distribution. The general situation of the spin-orbit splitting is discussed in terms of the known properties of the nucleon–nucleon interaction. (auth)

16087 EXTENSION OF THE RANDOM PHASE APPROXIMATION. Da Providencia, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A108: 589-608(1968).

A theoretical scheme appropriate for generalizing the Hartree–Fock and RPA theories to include ground state correlations is developed. The Beliaev-Zelevinsky expansion is used for expanding the Hamiltonian in boson operators. The ground state wave func-

tion is defined as the independent boson wave function which minimizes the expectation value of the Hamiltonian. It follows that the ground state cannot mix with one- or two-boson wave functions, and this condition yields immediately equations generalizing the Hartree–Fock and the RPA equations. By considering the oscillations of slightly modified independent-boson wave functions around the equilibrium position, the boson-boson correlations due to anharmonic effects are introduced. Finally, it is shown that the approach possesses formal properties similar to those of the RPA theory. (auth)

16088 NEW PARAMETERS FOR SCATTERING OF 18.6 MeV POLARIZED PROTONS. Kossanyi-Demay, P.; De Swiniarski, R. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A108: 577-88(1968).

Optical-model and coupled-channel calculations are presented for the scattering of 18.6 MeV polarized protons from medium-weight nuclei using parameters which are consistent with the analysis of higher-energy data. Reasonable elastic fits and improved inelastic fits are obtained by reducing the radius of the central real potential with respect to the radius of the imaginary potential which is increased from the previous Perey value. The diffuseness of the real potential is larger than has previously been inferred, while the diffuseness of the imaginary potential is unchanged. The elastic and inelastic data are analyzed using a derivative spin-orbit form factor instead of the Thomas form factor usually used to describe the spin-orbit coupling. The fits obtained are in very good agreement with those found by using the usual $1/r$ dependence. The symmetry term or $(N-Z)/A$ dependence of the potential is derived either for the central real potential or for the imaginary potential and appears to give satisfactory agreement with other recent optical-model analyses, if the ^{54}Fe data are not taken into account. It is shown that the symmetry terms corresponding to V_s and W_D do not depend on the geometrical parameters used for the analysis. (auth)

16089 EQUATIONS-OF-MOTION METHOD AND THE EXTENDED SHELL MODEL. Rowe, D. J. (Univ. of Rochester, N. Y.). Rev. Mod. Phys., 40: 153-66(Jan. 1968).

The equations-of-motion method is presented as a useful and flexible tool in the study of nuclear spectroscopy. It is partly a review, but also it introduces a new and much more powerful equations-of-motion technique which supercedes the older linearization methods. The older methods worked with operator equations. To obtain closed expressions they had to be linearized in a rather arbitrary manner. The present approach works with the ground-state expectation of operator equations and thereby avoids all problems of linearization. Thus, like the Green's function method, the equations-of-motion method becomes potentially exact. It has many advantages over Green's function methods, however, among which are its greater compactness, simplicity, and the physical insight it yields. The method is first applied to rederive the random phase approximation (RPA) and the quasiparticle RPA (QRPA) and to show precisely what terms they neglect. It is demonstrated that some of these terms have coherent phases. A higher RPA and QRPA are then derived to include these terms. The corrections have some interesting effects: notably, there is a reduction of the effective interaction strength and a stabilization of the nucleus against sudden phase transitions. The equations-of-motion method is also used to generalize, in a very simple and natural way, the Hartree–Fock (HF), and Hartree-Bogolyubov (HB) concepts of independent particles and quasiparticles to nonsimple ground states. The equations-of-motion method is presented as a simple extension of the shell model to the treatment of excitation of a correlated ground state. By concentrating on the quantities of direct physical interest, the complexity of working with correlated wavefunctions is avoided. (auth)

16090 SOME PROBLEMS OF THE THEORY OF NUCLEAR REACTIONS AT HIGH ENERGIES. Shapiro, I. S. (Inst. of Radiophysics and Electronics, Kharkov). Usp. Fiz. Nauk, 92: 549-82(Aug. 1967). (In Russian).

Two types of nuclear reactions are distinguished. In the first type, the energy and momentum of the incident particle are distributed over many degrees of freedom of the nucleus. At low and average energies the formation and decay of a compound nucleus is observed, while at high energies a large number of particles are emitted more or less at random. The second type includes the direct processes in which one or two particles carry away almost all the energy and momentum (nucleon, deuteron, triton, or alpha particle). General information on the amplitude, cross section, and phase volume as indicative of nuclear structure; the essence and physical content of Feynman diagrams, which avoid the explicit use of nuclear wave functions; and the use of polar diagrams at small transmitted momenta are reviewed. The differential cross section as a function of angle θ is illustrated for reactions of the type A(p,2p)B as follows: $^{6}Li(p,2p)^{5}He$ (16.69 MeV), $^{7}Li(p,2p)^{6}He$, $^{12}C(p,2p)^{11}B$, and $^{12}C(\pi^-,\pi^-n)^{11}C$. It would be experimentally desirable to demonstrate the Treiman-Yang criterion for reactions of the type A(x,xN)B at various transmitted momenta and by measuring the emission angles of the final particles and the energy of one of the particles. The form of the differential cross section $d\bar{\sigma}/dq$ as a function of q should be measured with identification of the state of the residual nucleus. Absolute cross sections should be measured near the πN resonances. Interaction in the final state, that is, rescattering of the virtual reaction products on the residual nucleus, is also considered. (TTT)

16091 CORRECTIONS TO ELECTROMAGNETIC TRANSITION RATES DUE TO GROUND-STATE CORRELATIONS. Da Providencia, J.; Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A108: 609-24(1968).

With the assumption that the two-particle-two-hole correlation structure of the nuclear ground state is given by the RPA result, some corrections to transition rates are calculated. These corrections decrease significantly the theoretical values for the transition strength of the dipole states in ^{16}O and are therefore in the direction of improving the agreement between theory and experiment. It is also found that appreciable transition strength may be obtained above the giant resonance region. Two mechanisms are considered in the later case: the direct excitation of high-energy two-particle-two-hole states proceeding via the ground-state correlations of the RPA theory; and the shifting of transition strength to higher energies via the mixing of the dipole states into two-phonon states at higher energies. In addition, corrections to the calculation of the form factors for two $J = 2^-$ ($T = 1$) states of ^{16}O are considered. The corrections arising from an analysis of the ground-state correlations are found to improve the agreement between theory and experiment when comparison is made to standard RPA calculations. (auth)

16092 NUCLEAR STRUCTURE. Based on Lectures Given at the International Seminar on Low-Energy Nuclear Physics held at Dacca, 16–25 January 1967. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967. 353p. $17.00.

Separate abstracts were prepared for each of the seventeen lectures presented. (B.G.D.)

For abstracts of individual papers see: 14763, 14764, 15884–15887, 15955, 15967, 15968, and 16093–16100.

16093 NUCLEAR PHYSICS IN PAKISTAN. Salam, Abdus (International Centre of Theoretical Physics, Trieste, Italy). pp ix-xiii of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A brief review is given of the state of nuclear physics in Pakistan. (S.F.L.)

16094 ISOSPIN MIXING IN NUCLEAR GROUND STATES AND FERMI β-DECAYS. Bohr, A.; Damgard, J.; Mottelson, B. R. (Niels Bohr Inst., Copenhagen. Univ. of Copenhagen. NORDITA, Copenhagen). pp 1-10 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

The most quantitative tests of isobaric symmetry in nuclear ground states are provided by the ft values of the $0^+ \rightarrow 0^+$ transitions in even-A nuclei with $T = 1$. The effects of the calculated isospin mixing on these ft values are calculated and are compared with the available experimental data. Estimates of the isospin mixing are made using the shell and hydrodynamical models and tests of isospin impurities from Fermi β decays are made. (S.F.L.)

16095 REVIEW OF NUCLEAR REACTION THEORIES. Huby, R. (Univ. of Liverpool). pp 11-33 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

The kinds of problem confronting the theory of nuclear reactions are surveyed by listing various types of observed behavior, e.g., direct and compound processes, giant and intermediate resonances, etc. Direct reaction theory is discussed with examples in order to elucidate the meaning of a direct process and to separate direct and compound processes. In the theory of the compound nucleus the meaning of the term resonance is investigated by way of some "natural" definitions of a resonance, including that of Humblet and Rosenfeld. The problem of low-energy scattering of a neutron by a spin-zero nucleus is taken as an illustration, so as to compare the formulae yielded by various well-known theories. Among the theories which are critically reviewed are those of Kapur and Peierls, Wigner, Feshbach, and the continuum-shell-model theory. It is concluded that no single theory can constitute a unified theory

of reactions expressing succinctly at once all the physical mechanisms which occur, and permitting highly accurate calculations of the scattering amplitude; but the different theories have their own characteristic spheres of usefulness. (auth)

16096 ROLE OF THE ROTATION PARTICLE COUPLING IN DETERMINING NUCLEAR PROPERTIES. Malik, F. B.; Scholz, W. (Yale Univ., New Haven). pp 34-57 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

The influence of the rotation–particle coupling (RPC) on excitation spectra, moments, and transition rates is discussed. It is pointed out that a proper treatment of this RPC predicts the ground state spin of most odd light nuclei correctly, including such anomalous ones as $3/2^-$ for ^{47}V, $5/2^-$ for ^{47}Ti and ^{51}Mn; whereas the omission of RPC in the simple application of the rotator model can not account for many of these ground state spins. Moreover the inclusion of RPC accounts for the low lying spectra of most of the light odd nuclei. Such anomalous features as the occurrence of low lying positive parity states in odd isotopes of Scandium follows as a simple consequence of this model. As examples, spectra of ^{23}Na, ^{25}Mg, ^{25}Al, ^{27}Al, ^{29}Si, ^{43}Sc, ^{47}Sc, and ^{47}V computed in the Coriolis coupling model are presented. Especially for nuclei in the $1f_{\frac{7}{2}}$ shell the inclusion of bands based on core excited states is found to be important. The RPC influences considerably the moment of inertia and the band head energies. The effect of RPC on the magnetic and quadrupole moments can be very important and a proper inclusion of RPC predicts magnetic and quadrupole moments in reasonable agreement with observation without using any effective charge. Presence of such an interaction is capable of giving vanishingly small quadrupole moments and may result in a spectroscopic quadrupole moment having a different sign than the intrinsic one. RPC can retard by a large factor the M1 transitions which are otherwise allowed in the rotator model. The inclusion of RPC can moreover account for the enhanced quadrupole transition probabilities without using any effective charge. Thus the apparent paradoxical result of having enhanced B(E2) in the same nucleus which has vanishingly small quadrupole moment is explained as a consequence of RPC. These results lead to suggest that a deformed shell model presents a more appropriate description of light nuclei. (auth)

16097 GAMMA RAY SPECTROSCOPY OF NUCLEAR REACTIONS. Morinaga, H. (Tokyo Univ.). pp 76-84 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

Gamma ray spectroscopy of nuclear reactions where nuclear reaction proceeds via compound states in continuum is discussed. The method essentially consists in looking at the terminating stage of a nuclear reaction process. Considerable spectroscopical information may be obtained even when only the intermediate part of the process is statistically known. First, a rather clean-cut example of gamma rays following the (α,xn) reactions on heavy deformed nuclei is discussed in some detail and then some developments in this line of study, especially those in rather low energy reaction, are presented. (auth)

16098 SPECTRAL DISTRIBUTIONS IN NUCLEI. French, J. B. (Univ. of Rochester, N. Y.). pp 85-123 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

Instead of attempting a detailed solution of a spectroscopic problem one can consider the way in which a basis wave function distributes among the eigenstates of the system. Such distributions when averaged over all the states of the system, or over appropriate sub-sets (which in fact will be representations of various groups), can be studied by means of their low-order energy moments. Methods for calculating such moments are given for significant cases and some general discussion is given about the way in which the information carried by such moments "propagates" throughout the representation space. Some configuration moments are discussed in detail and some future extensions and applications are mentioned. (auth)

16099 SUM RULE METHODS IN NUCLEAR SPECTROSCOPY. French, J. B. (Univ. of Rochester, N. Y.). pp 124-37 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

A discussion is given of multipole sum rules as they may be applied to the analysis of single-nucleon-transfer reactions and to the study of vibrational states in nuclei. (auth)

16100 NEUTRON CAPTURE. Starfelt, N. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 160-80 of Nuclear Structure. Hossain, Anwar; Harun-ar-Rashid, [A. M.]; Islam, Mizanul (eds.). New York, John Wiley and Sons, Inc., 1967.

Available experimental information about γ-ray spectra emitted in the capture of neutrons of energies from 15 keV to 15 MeV is reviewed. Comparison is made with γ-ray spectra from $(n,n'\gamma)$ and $(d,p\gamma)$ reactions. Possible reaction mechanisms are discussed. (auth)

16101 A STUDY OF HIGHER ORDER EFFECTS IN COULOMB EXCITATION. Nebel, Henry. Buffalo, State Univ. of New York, 1967. 119p.

Thesis.

The second-order theory of Coulomb excitation is studied in detail in the semi-classical treatment, i.e., a classical orbit is assumed for the path of the projectile and the interaction due to the nuclear structure is treated quantum-mechanically using perturbation theory. Particular attention is paid to the reorientation effect which has been proposed as a means of measuring static quadrupole moments (Q_{22}) of first excited 2^+ states in even-even nuclei. The reorientation effect involves excitation of the nucleus from its ground state to one magnetic sublevel of the final state followed by a transition between magnetic sublevels of that state due to the interaction of the projectile with the static moment of the final state. Measurement of the effect in even-even nuclei can provide a determination of the sign as well as the magnitude of Q_{22}. It has been suggested that second-order virtual E1 transitions through the giant dipole resonance might be important in such a measurement. If this were the case, the experimental value measured recently would be subject to question. The E1 correction is studied for deformed nuclei on the basis of a dynamic collective nuclear model which allows for rotations, surface quadrupole vibrations, and higher energy giant resonance oscillations. The probabilities for reorientation and for the E1 correction are compared under the conditions that are most favorable for reorientation measurements. It is found that the E1 effect constitutes less than a 10% correction to the reorientation effect for the rare earth nuclei. Consequently the E1 effect should not introduce a significant correction in a reorientation measurement of Q_{22}. It is emphasized that the magnitude of the E1 effect is of the order of the uncertainty of the reorientation calculation itself even under the most favorable bombarding conditions. (Disser. Abstr.)

16102 OSNOVY TEORII ATOMNOGO YADRA. (The Basic Theory of Atomic Nuclei). Malyarov, V. V. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1967. 512p.

The properties of atomic nuclei including the mass, electric charge, stability and binding energy, nuclear dimensions, spin, magnetic dipole moments, and nuclear shells are discussed in the first chapter of the textbook. Deuteron elementary theory, excitation states, and the theory of particle elastic scattering and collisions are covered in the second and third chapters. The next two chapters describe the nuclear forces and nuclear models. The problems of alpha and beta decay and γ radiation are discussed in the sixth, seventh, and eighth chapters. Inelastic scattering and basic nuclear reactions, resonance and photo effects, radiative capture of neutrons by protons, nuclear fission, and the inverse collision theory are discussed in the last chapter. 556 references are included. (R.V.J.)

16103 METOD KVAZICHASTITS V TEORII YADRA. (Quasiparticle Method in Nuclear Theory). Migdal, A. B. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1967. 160p.

For many processes the nucleus can be considered as a gas of quasiparticles, the interaction between which is characterized by a few constants determined from tests. This approach is explained graphically and used for the calculation of different phenomena of nuclear physics. The book is intended for students of physical institutes. (tr-auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 14470, 14477, 14622, 14624, 14626–14628, 14659, 15218, 15261, and 16356.

16104 (ACNP-64546(Add.)) REPORT ON THE FULL POWER OPERATION OF THE ELK RIVER BOILING WATER REACTOR. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Sept. 1964. Contract AT(11-1)-654. 24p. Dep. CFSTI.

The results of full power testing in the Elk River Reactor are presented. Noise analysis was performed at 25 and 100% power. During the initial escalation to full power, no pulsing was observed in either loop, but subsequent to this operation a slight periodic variation of the feedwater flow was observed. The plant-response-to-load-changes-test was performed, and the results demonstrated full plant capability for operation in all power ranges and at all rates of change that are compatible with the RCPA turbine requirements. (auth)

16105 (AECL-2497) FISSION PRODUCT ABSORPTION IN THERMAL REACTORS. Walker, W. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). [1966]. 17p. Dep. CFSTI. CAN.

A discussion of fission product buildup in thermal reactors is given. Yield measurements, cross sections, resonance integral determination, and fission product absorption are discussed. The most important fission products which are produced are listed with characteristic parameters for each. 50 references. (M.L.S.)

16106 (AECL-2795) EXPERIENCE WITH CANDU REACTORS AND THEIR POTENTIAL. Aikin, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1967. 13p. (CONF-671210-1). Dep. CFSTI. CAN $0.50.

From Conference on Prospects and Problems of Nuclear Power Applications in Developing Countries, Santiago, Chile.

Improvements and changes being developed in CANDU reactors are examined together with economics and possibilities for the future. NPD has successfully demonstrated the CANDU-PHW (pressurized heavy water) reactor concept. Though early operating experience of the Douglas Point PHW-200 MWe reactor was beset with mechanical problems, this power source is expected to meet the targets set. Four similar 500 MWe units on one site are under construction at Pickering. Reactors of the same type are being built in India and Pakistan. The BLW (boiling light water) 250 MWe reactor concept has been tested in large scale loops and construction has begun at Gentilly in Quebec. WR-1, an organic cooled reactor, has performed so well that interest in this system has been revived. Fuel costs are now less than 0.6 mill/kWh without Pu credit. New materials and fuel cycles are being developed. The capital costs of large size plants are competitive with other systems but higher in small sizes. Cost reduction studies on small plants are underway. (9 references). (auth)

16107 (AEEW-R-539) THE RAPID CALCULATION OF FREQUENCY RESPONSES FOR LINEAR SYSTEMS INVOLVING TIME-DELAYED TERMS (FORTRAN PROGRAM FRP Mk 2). Sumner, Helen M. (Atomic Energy Establishment, Winfrith (England)). July 1967. 40p. Dep. CFSTI. UK 6s. 0d.

A program, entitled FRP Mk 1, for computing the frequency response of a linear system, with transport delays, has been developed previously. The minimisation of time and storage requirements is studied. In particular, if the system is described by a set of first order differential and algebraic equations, some variables, specified by the programmer may be eliminated by the computer. The method is incorporated in the KDF 9/EGDON code FRP Mk 2, and includes special non-numeric, compiler subroutines for input of the equations and other data in a simple form orientated towards the analyst. The input scheme used for the equations is compatible with that used for the pole-zero, or transfer function program, ZIP so that the same card-deck may be used for data entry in both codes. The code FRP Mk 2 was designed to be used for the analysis of nuclear reactor power systems, but is equally applicable to most forms of process plant, especially chemical plant. (auth)

16108 (BMI-1825) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, October–December 1967. Morrison, David L.; Carbiener, Wayne A.; Ritzman, Robert L.; Blutreich, Joachim N.; Clark, William E.; Denning, Richard S.; Gieseke, James A.; Redmond, Robert F.; Wooton, Roger O. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1968. Contract W-7405-eng-92. 28p. Dep. CFSTI.

The consequences of a loss-of-coolant, or blowdown, accident in boiling-water and pressurized-water reactors were investigated. Calculations were performed to provide an analytical description of the thermal and hydraulic conditions in the core and the fission-product behavior following such accidents. (H.D.R.)

16109 (BNWL-609) PROCEEDINGS OF AEC-INDUSTRY MEETING ON IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS, USAEC HEADQUARTERS, GERMANTOWN, MARYLAND, JULY 18, 1967. Bement, A. L.; Steele, L. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. 91p. (CONF-670721). Dep. CFSTI.

The working committees for the Irradiation Effects on Reactor Structural Materials Programs are discussed; committee members are outlined. Efforts and results of the BNWL program are given; Argonne contributions, especially in the field of LMFBR materials development, are presented; the BMI programs are described; Idaho Nuclear Corporation contributions are summarized; fracture toughness investigations for A302B steels are presented in some detail. The development of fast breeder reactor materials is discussed. Discussions by industry, utilities, and professional societies are presented. Outlines of programs are given for the following: Naval Research Lab, ORNL, G. E. Nuclear Materials and Propulsion Operation; BNL; General Atomic Division, and Westinghouse Electric Corporation–APDC (M.L.S.)

16110 (CEA-R-3274) ELIMINATION PROGRAMMEE DE POISONS NEUTRONIQUES DES REACTEURS NUCLEAIRES. (Program for Elimination of Neutron Poisons From Nuclear Reactors). de la Perriere, Gisele (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 83p. (In French). Dep.

The use of salts of elements having a large neutron capture cross-section, which are dissolved in the moderating water to control the reactivity of heavy-water reactors, and more particularly to compensate the Xe effect in the reactor EL 4 is discussed. The controlled elimination of these poisons by fixation on ion-exchange resins is described. The poisons considered are ^{6}Li, Cd and Gd in the sulfate form, and Bo as H_3BO_3. The thermodynamic and kinetic constants of the ion exchange reactions were first determined and a study was then made of the fixation of these compounds in beds of small-calibre resins placed in columns. ^{6}Li is the poison most easily applicable to compensate for the Xe effect in the EL-4. This application is discussed. 18 references. (auth)

16111 (CEA-R-3292) CONSIDERATIONS SUR LA FIABILITE DES ENSEMBLES DE SECURITE DES REACTEURS. (Considerations Concerning the Reliability of Reactor Safety Equipment). Furet, Jacques; Guyot, Christian (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1967. 39p. (In French). Dep.

The large amount of data available necessitates the use of a computer for analyzing the results. Reliability of the electronics used for nuclear reactor control will be dealt with: safe and unsafe failures, probability of survival (in the case of reactor safety) availability. The general diagrams of the safety assemblies which have been drawn up for power reactors and low power experimental reactors are given. Results of reliability analysis which could be applied to use of functional modular elements are presented. Improvement of this reliability appears fairly limited by increased redundancy; however it may be greatly improved by use of different frequency signals for detecting unsafe failure rates for the sub-assemblies. Examples show complexibility of reactor safety equipment and system dependence on reliability. (auth)

16112 (CEA-R-3311) LA POLLUTION RADIOACTIVE AUPRES DES PILES URANIUM NATUREL–GRAPHITE–GAZ. (Radioactive Contamination Near Natural Uranium–Graphite–Gas Reactors). Chassany, Jean; Pouthier, Jacques; Delmar, Jean (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Nov. 1967. 24p. (In French). Dep.

The results of numerous evaluations of contamination are given: reactors in operation during maintenance operations; reactors shut down during typical repair operations following incidents on the cooling circuit and can-rupture. They show that, except in particular cases, it is the activation products which dominate. Furthermore, after ten years operation, the points at which con-

tamination liable to emit strong doses accumulates are very localized. 11 references. (auth)

16113 (CEA-R-3335) SYSTEMES LINEAIRES SURVIVANT A LA PREMIERE PANNE. (Linear Systems Surviving the First Breakdown). Uberschlag, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 23p. (In French). Dep.

Linear safety systems for reactors, in which redundancy of like signals is not required, are described. The designs of systems, which require coincidence-redundancy, are given. Operation of, and errors and detection in such systems are briefly considered. (M.L.S.)

16114 (CEA-R-3341) COMPTE RENDU DES EXPERIENCES DE DEMARRAGE EN AVEUGLE EFFECTUEES SUR LE REACTEUR CABRI DU 4 AU 8 JUILLET 1966. (Report of Blind Startup Experiments Carried Out on the Reactor CABRI Between July 4 and 8, 1966). Filipczak, Nadejda; Filipczak, Wieslaw; Furet, Jacques; Kaiser, Josef (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 24p. (In French). Dep.

The blind startup of a reactor without any neutronic data concerning a relatively wide range of power dynamics can be necessary when difficulties arise in the positioning of the detector or in neutron–gamma discrimination near the multiplying medium. The object of the experiments carried out on the reactor CABRI was to check the very complete analysis of the startup accident which was studied on an analogue computer. The number of experiments carried out is not sufficient to allow a definite conclusion. Nevertheless the blind startup method presented does not appear to be incompatible with the safety of reactors such as CABRI during the operational phase. (auth)

16115 (CEA-R-3380) ETUDE DE LA FIABILITE DES SYSTEMES DE PILOTAGE AUTOMATIQUE DES REACTEURS NUCLEAIRES. (Study of the Reliability of Automatic Control Systems for Nuclear Reactors). Tapu, Cornel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 32p. (In French). Dep.

The reliability of automatic control systems which can be applied to nuclear reactors is evaluated. The calculations which have been carried out make possible the orientation of the choice of the scheme and of the elements used, as a function of the operational safety. Sequential and parallel redundance showing the importance of the detection of active and passive failures, and of the maintenance are investigated. The failure rate coefficients for the elements used in an automatic control system design have been calculated using the data given by the "R.A.D.C. Reliability Note Book." (auth)

16116 (CEND-291) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF PIQUA CORE II. Kern, Richard; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Feb. 13, 1967. Contract AT(38-1)-428. 28p. Dep. CFSTI.

Specific application of the ISOCHECK method to Piqua Core II is straight-forward in that the distortion in the reactor geometry has been remedied and that no serious compromises in the representation of core compositions are required. The degree of accuracy generally characteristic of the state-of-the-art of reactor physics for H_2 moderated reactors should be obtainable in the use of the method. Accuracies of ±5% for ^{235}U depletion and ±8% for total Pu content can be expected for normal batches of operating fuel elements in the reactor. The accuracies apply for the batch as a whole, which may consist of, say, 20 or more fuel assemblies. The batch is the smallest unit of interest, insofar as isotopic content for fuel accounting purposes is concerned, because fuel reprocessing occurs in batch loads. (auth)

16117 (CEND-292) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF BIG ROCK POINT. Kern, Richard; Shesler, Albert T.; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Feb. 27, 1967. Contract AT(38-1)-428. 64p. Dep. CFSTI.

Use of the ISOCHECK method for determining the heavy isotope content in the Big Rock Point core is detailed. Exposure of fuel assemblies is calculated by FLARE using known locations and prior accumulated exposures, observed average position of control elements, and recorded history of thermal reactor power. Isotopic composition is obtained from tables of isotopic composition vs fuel exposure. A discussion of the function of the FLARE program within the framework of the ISOCHECK method is given. 20 references. (M.L.S.)

16118 (CEND-296) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF BONUS CORE I. Kern, Richard; Forbes, Ann (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Apr. 17, 1967. Contract AT(38-1)-428. 78p. Dep. CFSTI.

Use of the ISOCHECK method for determining heavy isotope content in the BONUS initial core loading is detailed. Exposure of fuel assemblies is calculated using FLARE; isotopic composition is then determined by comparison against a table of isotopic composition vs fuel exposure. A discussion of the function of the FLARE program within the framework of the ISOCHECK method is given. 21 references. (M.L.S.)

16119 (CEND-299) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF NINE MILE POINT CORE I. Kern, Richard; Shesler, Albert T. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Apr. 28, 1967. Contract AT(38-1)-428. 39p. Dep. CFSTI.

Specific application of the ISOCHECK method to Nine Mile Point Core I is straightforward in that no distortion of reactor geometry or serious compromises in the representation of core compositions are required. The degree of accuracy generally characteristic of the state-of-the-art of reactor physics for water reactors should be obtainable in the use of the method. Accuracies of ±5% for ^{235}U depletion and of ±8% for total Pu content can be expected for normal batches of operating fuel elements in the reactor. The accuracies apply for the batch as a whole, which may consist of, say, 20 or more fuel assemblies. The batch is the smallest unit of interest, insofar as isotopic content for fuel accounting purpose is concerned, because fuel reprocessing occurs in batch loads. (auth)

16120 (CEND-308) FEASIBILITY STUDY OF VARIOUS CALCULATIONAL MODELS AND EVALUATION OF THE EXPECTED ACCURACIES OF PREDICTED ISOTOPIC CONCENTRATIONS IN FAST REACTOR CORES. Kern, Richard; Shesler, Albert T. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). May 12, 1967. Contract AT(38-1)-428. 29p. Dep. CFSTI.

The results of the feasibility study and evaluation of the accuracies of predicted isotopic concentrations for fast reactors are presented. Results presented include: descriptions of various models along comparisons of calculational versus experimental results obtainable with each; evaluation of the accuracies of predicted isotopic concentrations of the various models; and recommendations for setting up a method similar to ISOCHECK by which the isotopic content in operating fuel elements of fast reactors can be checked. (auth)

16121 (CEND-317) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENT OF DRESDEN I CORE V. Kern, Richard (Combustion Engineering, Inc., Windsor, Con . Nuclear Div.). Nov. 17, 1967. Contract AT(38-1)-428. 64p. Dep. CFSTI.

The results of the calculations which were performed in order to update the ISOCHECK Method for Dresden I Core V are presented. The results are presented in a form such that the existing ISOCHECK Method for Dresden I can be modified to incorporate the necessary changes. FLARE packages have been prepared for a typical set of operating conditions near the beginning of life of Core V in order to display the means for modifying the original ISOCHECK Method. Sufficient information is supplied to enable correct punching of all physics parameters and operational data onto punched cards. (auth)

16122 (CEND-318) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF HUMBOLDT BAY CORES IIIA AND IIIB. Kern, Richard; Shesler, Albert T. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Dec. 8, 1967. Contract AT(38-1)-428. 45p. Dep. CFSTI.

The application of the ISOCHECK Method to Humboldt Bay Cores III A and III B is straightforward, in that no distortion of the reactor geometry was required. In addition, the approximation used to eliminate the problem resulting from the burnout characteristics of the poison shims will not introduce any serious errors into the analysis, as is demonstrated. The degree of accuracy of the method is that generally characteristic of the state of the art of reactor physics for water reactors. These accuracies are ±5% for ^{235}U depletion and ±8% for total Pu content for normal batches of operating fuel elements in the reactor, and they are identical to the accuracies quoted for the results which are obtainable with the ISOCHECK Method as applied to Core II. (auth)

16123 (CONF-671011) INCIPIENT FAILURE DIAGNOSIS FOR ASSURING SAFETY AND AVAILABILITY OF NUCLEAR POWER PLANTS. Proceedings of the Conference held at Gatlinburg, Tennessee, October 30–November 1, 1967. (Oak Ridge National Lab., Tenn. Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Jan. 1968. 392p. Dep. CFSTI.

Included are 29 papers on developments in the fields of incipient failure detection, on-line detection and diagnosis of component and system malfunction, and measurement of component and system degradation in nuclear power plants. A separate abstract was prepared for each of 18 papers. Abstracts of two papers were included in previous issues of NSA, see CONF-671011 in the Report Number Index. (H.D.R.)

For abstracts of individual papers see: 14606, 14607, 14737, 14738, 16124–16129, 16247, 16273–16276, and 16311–16313.

16124 (CONF-671011–, pp 58-60) EXPERIENCE WITH AN ON-LINE REACTIVITY BALANCE CALCULATION AS A GUIDE FOR REACTOR OPERATION. Engel, J. R. (Oak Ridge National Lab., Tenn.).

During operation of the Molten Salt Reactor Experiment a reactivity balance is calculated every 5 minutes by an on-line digital computer. The balance is the algebraic sum of all expected reactivity changes from a reference condition established at the start of power operation, and is used to monitor the reactor performance on-line. Results of reactivity balance calculations at zero power and during power operation are presented. (H.D.R.)

16125 (CONF-671011–, pp 211-19) MALFUNCTION DETECTION SYSTEMS FOR LIQUID-METAL FAST BREEDER REACTORS. Nims, J. B. (Atomic Power Development Associates, Inc., Detroit, Mich.).

A program for the development of an on-line digital computer system for the Fermi Fast Breeder Reactor is described. The goal of the program is a system that would function as a generalized malfunction detection analyzer. The proposed analyzer would initially treat three items: the reactivity balance, core assembly temperature changes, and the cover gas fission product activities. Some details of the three signal interpretations are described. (H.D.R.)

16126 (CONF-671011–, pp 220-7) DESIGNING FOR IN-SERVICE INSPECTION. Wylie, R. D. (Southwest Research Inst., San Antonio, Tex.).

Demands for structural integrity of power reactor equipment over the projected life of the plant has created interest in the development of inspection techniques for assuring this integrity. Some of the problems associated with the use of mechanized ultrasonic systems as periodic inspection devices for primary pressure boundaries of nuclear systems are reviewed. Particular regard is paid to accessibility for inspection by consideration of the engineering requirements of inspection at the design stage of the nuclear systems. (H.D.R.)

16127 (CONF-671011–, pp 228-37) DETECTION OF LEAKS IN INACCESSIBLE AREAS OF THE BOILING-WATER-REACTOR NUCLEAR POWER PLANT. Klose, A. H.; Miller, D. R. (General Electric Co., San Jose, Calif.).

The detection of leaks from the nuclear steam supply system inside the drywell of a pressure suppression containment for a large boiling water reactor (BWR) is discussed. Instrumentation currently in use by the General Electric Co. is shown to give leak detectability to below 5 gpm of condensate using instrumentation such as flowmeters, temperature sensors, and pressure sensors. (auth)

16128 (CONF-671011–, pp 355-66) CASE HISTORY OF THE ENRICO FERMI REACTOR INCIDENT: ANOMALOUS REACTIVITY AND FISSION-PRODUCT ANALYSES. Klickman, A. E. (Atomic Power Development Associates, Inc., Detroit, Mich.).

On October 5, 1966, anomalous events occurred during the operation of the Fermi reactor which were caused by the melting and displacement of fuel in several subassemblies. These events are interpreted in an attempt to establish the time history and extent of the melting. The anomalous regulating rod history is interpreted to provide information on anomalous reactivity effects. The fission product release is analyzed from information on the radioactivity in the containment building, the cover gas, and the primary coolant. (H.D.R.)

16129 (CONF-671011–, pp 367-9) THE EFFECTS OF SUBASSEMBLY BOWING IN THE EBR-II. Smith, R. R. (Argonne National Lab., Idaho Falls, Idaho).

The reduction in power coefficient values during runs in the Experimental Breeder Reactor-II following major changes in core loading is described. This effect is postulated to be the result of the bowing of fuel subassemblies because of reversed thermal gradients in fuel subassembly rows. (H.D.R.)

16130 (DOCKET-50285–15) FORT CALHOUN STATION UNIT NO. 1. VOLUME I. FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. (Omaha Public Power District, Nebr.). [1967]. 392p. Dep. CFSTI.

Material on Fort Calhoun Power Reactor, Unit 1, is contained under the following topics: Introduction and summary description; Site and Environs; Reactor including design bases, mechanical design, nuclear design, and thermal and hydraulic design; Reactor Coolant System; Containment System; and Engineered Safeguards including the safety injection system, the containment spray system, containment air recirculation and cooling system, cooling water system, reliability, and missile protection. (M.L.S.)

16131 (DOCKET-50285–16) FORT CALHOUN STATION UNIT NO. 1. VOLUME II. FACILITY DESCRIPTION AND SAFETY ANALYSIS REPORT. (Omaha Public Power District, Nebr.). [1967]. 298p. Dep. CFSTI.

Material for Fort Calhoun Power Reactor, Unit 1, is included under the following topics: Instrumentation and Controls including the protective system, regulating systems, engineered safeguards systems–containment spray, safety injection, containment air recirculation and cooling, and cooling water pumps–nuclear instrumentation, process instrumentation, radioactivity instrumentation, in-core instrumentation, operating control stations, communications, and emergency power requirements; Electrical Systems; Auxiliary Systems including chemical and volume control, shutdown cooling system, auxiliary feedwater system, refueling system, spent fuel pool cooling system, component cooling system, raw water system, service water system, air conditioning system; fire protection, compressed air system, and sampling system; Steam and Power Conversion Systems; Radioactive Waste Disposal and Control Systems; Radiation Protection and Monitoring; Structures other than Containment; Pre-Operational Test Program and Procedures; Safety Analysis of Core and Coolant Boundary Protection; and Safety Analysis of Standby Safeguards. Also included are the Dawes and Moore report on Site and Environmental Studies, and Geologic Studies. (M.L.S.)

16132 (DOCKET-50285–2) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 2, Suppl. 2, Exhibit F-2. (Omaha Public Power District, Nebr.). Sept. 15, 1967. 244p. Dep. CFSTI.

Effects of containment height on prestress, pressure, design earthquake, wind, and liner and concrete thermal loadings are analyzed. Some details in containment vessel construction are provided. A discussion of the safety injection and containment spray pumps relative to their location and functioning is given. An analysis of containment vessel pressure and temperature as a function of time during the design basis accident is given; results are shown graphically. Containment vessel penetrations are listed; System pressures and two phase volumes and water volumes are shown for various break sizes. Cladding failure and fuel melting under design basis accident (DBA) conditions are evaluated. Accumulation of hydrogen, from radiolytic decomposition of coolant, in the containment building is determined. The reactor safety system is analyzed with respect to operation under accident conditions. Effects of loss of load demand are discussed; design criteria for valves are given. Transient effects on coolant boiling, peak heat flux and enthalpy conditions, and hot channel factors are detailed. Radial power distribution and DNB ratios are shown for overpower and nominal conditions. Control rod and control rod drive tests and results are detailed. Analysis of simultaneous withdrawal of all rods is given. A control rod ejection analysis is detailed. (M.L.S.)

16133 (DOCKET-50285–3) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 3, Suppl. 3, Exhibit F-3. (Omaha Public Power District, Nebr.). Sept. 25, 1967. 234p. Dep. CFSTI.

The general analytical model for seismic design is given. Containment vessel liner details are included. Compliance with the General Design Criteria requirements of 32FR10213 is delineated. Leakage rates of recirculating water in the engineered safeguards systems is analyzed. Design bases used for establishing the heat transfer capability of the containment spray system are given. Environmental consequences of the design basis accident are detailed; calculational models are given. Maximum fission and corrosion product activity in the reactor coolant is tabulated. Fission product activity release during a fuel handling incident is considered. (M.L.S.)

16134 (DOCKET-50285–4) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, [Amendment 4], Suppl. 4, Exhibit F-4. (Omaha Public Power District, Nebr.). Sept. 15, 1967. 6p. Dep. CFSTI.

Pile foundation design for Class I structures is presented. Data on the Fort Calhoun Site are given. The pile test program is discussed. (M.L.S.)

16135 (DOCKET-50285–5) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 5, Suppl. 5, Exhibit F-5. (Omaha Public Power District, Nebr.). Sept. 29, 1967. 58p. Dep. CFSTI.

Non-axisymmetric loadings of the Fort Calhoun containment vessel are analyzed. Effects of breaks in the hot leg and cold leg of the Emergency Core Cooling System are evaluated. An analysis of thermal shock to the reactor vessel during operation of the Emergency Core Cooling System is presented. Ability of the fuel to withstand expected transients toward the end of the fuel lifetime is evaluated. Environmental contamination resulting from a design basis accident is considered. (M.L.S.)

16136 (DOCKET-50285–6) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 6, Suppl. 6, Exhibit F-6. (Omaha Public Power District, Nebr.). Oct. 6, 1967. 42p. Dep. CFSTI.

Details on foundation and construction of the containment system are given. The surveillance program for assurance of continuing containment vessel integrity is described. (M.L.S.)

16137 (DOCKET-50285–7) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 7, Suppl. 7, Exhibit F-7. (Omaha Public Power District, Nebr.). Oct. 27, 1967. 82p. Dep. CFSTI.

Information on pile load testing and foundation construction of Fort Calhoun is given. An elastic critical buckling analysis of the containment vessel liner panel is detailed. Supplementary information is given on the safety injection system. Emergency Core Cooling System, air recirculation and cooling system, instrumentation and electrical systems, and design criteria for steam line isolation valves. Consequences of total loss of electrical power are analyzed. (M.L.S.)

16138 (DOCKET-50285–9) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 11, Suppl. 11, Exhibit F-11. (Omaha Public Power District, Nebr.). Dec. 8, 1967. 90p. Dep. CFSTI.

An ultimate strength analysis for the Fort Calhoun containment vessel is detailed. Principal stress plots for anchor loadings are given. Liner and tendon stresses are tabulated. Potential dose rates due to pipe rupture in the engineered safeguards systems are considered. Supplemental information on reactor vessel integrity when subjected to thermal shocks induced by Emergency Core Cooling System operation is given. The problem of soil liquefaction during an earthquake is considered with respect to reactor safety. The plant protection system and instrumentation is described in detail. Proposed determination of moderator temperature and density coefficients is detailed. (M.L.S.)

16139 (DOCKET-50285–10) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 12, Suppl. 12, Exhibit F-12. (Omaha Public Power District, Nebr.). Dec. 21, 1967. 22p. Dep. CFSTI.

Effects of flood peak stage of the Missouri River on Fort Calhoun feedwater intake are analyzed. A diagram showing the relation of the shutdown cooling system to the safety injection and containment spray systems is given. (M.L.S.)

16140 (DOCKET-50285–11) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 13, Suppl. 13, Exhibit F-13. (Omaha Public Power District, Nebr.). Dec. 21, 1967. 21p. Dep. CFSTI.

Loading combinations and primary stress limits for the Fort Calhoun containment vessel and associated Class I structures are tabulated. Stress limits for reactor vessel internal structures are given. (M.L.S.)

16141 (DOCKET-50285–12) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 14, Suppl. 14, Exhibit F-14. (Omaha Public Power District, Nebr.). Jan. 8, 1968. 69p. Dep. CFSTI.

Information for updating the original Preliminary Safety Analysis Report (PSAR) is given. Changes for each section of the PSAR are given in a corresponding section of this amendment. Revisions or corrections for each section are listed accordingly. No additional information on Fort Calhoun is given. (M.L.S.)

16142 (DOCKET-50285–13) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 15, Suppl. 15, Exhibit F-15. (Omaha Public Power District, Nebr.). Jan. 25, 1968. 19p. Dep. CFSTI.

Supplementary information on the financial qualifications of Omaha Public Power District, owner of Fort Calhoun Station-Unit 1, are given. Revisions of previous exclusion distance dose rates associated with a design basis accident are given. (M.L.S.)

16143 (DOCKET-50285–14) FORT CALHOUN STATION UNIT NO. 1. Facility Description and Safety Analysis Report, Amendment 16, Suppl. 16, Exhibit F-16. (Omaha Public Power District, Nebr.). Jan. 31, 1968. 10p. Dep. CFSTI.

Supplementary material on the outside electrical power supply, control rod insertion capability, and design of reactor protection system is included. (M.L.S.)

16144 (DPST–68–83–1) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, JANUARY 1968. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 24, 1968. Contract AT(07-2)-1. 7p. Dep. CFSTI.

The schedule for measurements of the temperature coefficients of reactivity for organic-cooled lattices with simulated burned-up UO_2 fuels are presented. Of seven lattices containing simulated burned-up fuel, two with D_2O coolant are measured at temperatures up to 80°C and five organic-cooled lattices are measured at temperatures up to 250°C. Work on the HAMMER computer routine for physics measurements of fuel assemblies consisting of clusters of fuel rods is described. (auth)

16145 (EUR–3736) SPECTRUM INDICES MEASUREMENTS IN ORGEL TYPE UC CLUSTER FUEL ELEMENTS. Conti, F. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 7, 1967. 40p. Dep.

Results of index spectrum measurements performed in natural UC cluster type fuel elements are described. Both the epithermal and the thermal spectrum indices were determined by means of integral activation techniques, using foil detectors with resonances, respectively in the epithermal and maxwellian regions. The resonance activities are normalized to that of a 1/V detector; The activity ratios are interpreted with the aid of the Westcott's convention. (auth)

16146 (GA–8075) A SURVEY OF TECHNICAL CONSIDERATIONS APPLICABLE TO AN ON-LINE REFUELING SYSTEM FOR LARGE HTGR'S. Paget, J. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1967. Contract AT(04-3)-167. 108p. Dep. CFSTI.

REACTORS, POWER — refueling of, evaluation of on-line
REACTORS, GAS-COOLED — refueling of, evaluation of on-line
REACTOR LOADING MACHINES — operation of large power reactor, summary of
BIBLIOGRAPHIES — on reactor refueling
PEACH BOTTOM POWER REACTOR, UNIT 1 — design parameters and layout of
HIGH TEMPERATURE GAS-COOLED REACTOR EXPERIMENT, MARCOULE REACTORS (G-2), MARCOULE REACTORS (G-3), CHINON REACTORS (EDF-1), CHINON REACTORS (EDF-2), CHINON REACTORS (EDF-3) — design parameters and layout of
SAINT LAUREUT-des-EAUX REACTOR (EDF-4), BERKELEY REACTORS, BRADWELL REACTORS, HEWTERSTON REACTORS, HINKLEY POINT REACTORS, TRAWNSFYNYDD REACTORS, LATINA POWER REACTOR, TOKAI-MURA POWER REACTOR, DUNGENESS REACTORS, SIZEWELL REACTORS, OLDBURY REACTORS, WYLFA REACTORS, WINDSCALE ADVANCED GAS-COOLED REACTOR, NPD REACTOR, CANDU REACTOR, AVR REACTOR, LOS ALAMOS TURRET REACTOR — design parameters and layout for (M.L.S.)

16147 (GA–8083) HIGH-TEMPERATURE ADSORPTION STUDIES FOR THE PSC REACTOR DEVELOPMENT PROGRAM. Lofing, D. R.; Burnette, R. D. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 30, 1967. Contract AT(04-3)-633. 18p. Dep. CFSTI.

Experimental work related to the high-temperature filter-adsorber unit for the Fort St. Vrain Power Reactor is described. Specific tests included measurements of dust or aerosol penetration as well as dynamic iodine adsorption under simulated reactor conditions of pressure, temperature, and gas velocity. (auth)

16148 (GA–8370) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION

RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending October 31, 1967. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 30, 1967. Contract AT(04-3)-314. 44p. Dep. CFSTI.

An operations history of Peach Bottom, Unit 1 is given. Plant thermal efficiency is shown as a function of power; results of temperature coefficient measurements are shown. Control rod calibration is discussed; integral and differential worth curves are shown. Xenon buildup and measurements are compared with calculated values. Results of power coefficient measurements are tabulated. Efficiency of the helium purification system is evaluated; impurity analyses are given. Release of noble gas fission products is shown as a function of fuel burnup. (M.L.S.)

16149 (GEAP-5517) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 19. Worthington, J. T. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). July 1967. Contract AT-(04-3)-189. 32p. (EURAEC-1907). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Analysis of the stability test results is presented. Closed-loop transfer function results are presented for each test condition as obtained from digital data reduction. Bode plots of the responses of signals from a number of in-core ion chambers are shown, together with the local neutron flux level in the vicinity of each ion chamber during the tests. (auth)

16150 (HPR-92) EXPERIENCE WITH HEAVY WATER MANAGEMENT IN THE HALDEN REACTOR DURING OPERATION ON ITS SECOND FUEL CHARGE. Jamne, E.; Wood, J. I. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 57p. Dep.

The heavy water management and the experiences with losses and degradation of heavy water during the operational period for the second fuel loading are presented. During the second fuel loading the reactor operated at power levels up to 20MW and at temperatures up to 230°C with availability close to 70 per cent. (auth)

16151 (INR-842/C) BYSTRYE BRIDERY NEPOSREDSTVENNO OKHLAZHDAEMYE KIPYASHCHIM TEPLONOSITELEM. (Fast Breeder Reactors With Direct Boiling Coolants). Taube, Mechislav (Institute of Nuclear Research, Warsaw (Poland)). 1967. 71p. (In Russian). Dep.

Classification system of fast nuclear reactors is discussed. Concepts of fast breeders fueled with fused chlorides of U, Pu, Na(K), and cooled directly with boiling coolant are discussed. The SAWA homogeneous boiling reactor with AlCl as coolant, and the WARS reactor boiling heterogeneously with $Hg_{met.}$ as boiling coolant are described. Some preliminary calculations for 1000 MW(t) reactors of both types were performed. Safety conditions and specific "bubble effect" are discussed. Some remarks about the fuel recycling are given. (auth)

16152 (JAERI-1147) DETECTION OF FAILED FUEL AT JPDR. Makino, Kiyoshi (Japan Atomic Energy Research Inst., Tokyo). Feb. 1967. 23p. Dep.

An abnormally high level of radioactivity was detected in the off gas system of JPDR on December 22, 1964. The source of this high radioactivity was fission products, including Kr-85 m, Xe-133 and -135, and this phenomenon was considered to be due to the fuel (failed fuel) which was releasing fission products into the coolant in the reactor core. After burning the core fuel for about one more year, the various tests were carried out on the location and detection of failed fuel in the reactor core. Results of the tests are described. (auth)

16153 (JAERI-1149) RADIATION MONITORING AND CONTROL OF THE JPDR. (Japan Atomic Energy Research Inst., Tokyo). May 1967. 44p. (In Japanese). Dep.

The JPDR nuclear power plant has a heat output of 45,000 kilowatts, corresponding to a electric output at the turbine generator of 12,500 kilowatts. The reactor is of the natural-circulation, direct-cycle, light-water cooled and moderated type. A description is given of the policy of radiation monitoring, radiation control and monitoring instrumentation. The measured results are given of the radiological monitoring for the three year period of Dec. 1964 to Mar. 1967. These results are included. A description of radiation levels in the working areas and the radiation dose received by personnel is given. The gamma radiation-levels measured around the reactor vessel agreed well with the calculated values. The airborne and surface contaminations were not so high as to cause any radiation hazards. (auth)

16154 (KFK-644) "BAKO": EIN PROGRAMM ZUR KOSTEN- UND STRATEGIENBERECHNUNG BEI BRUETERKRAFTWERKEN NACH DER BARWERTMETHODE. ("BAKO": A Program for Cost- and Strategy-Calculations for Nuclear Power Breeders by the Bare Value Method). Jansen, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 9p. (In German). (EUR-3705). Dep.

A computer program for calculating specific energy production from fast breeder nuclear power plants is given. The program writeup is given; calculational techniques are shown; some core loading plans are described, briefly. (M.L.S.)

16155 (LA-3789) A NUMERICAL STUDY OF EXCURSIONS IN UHTREX LOADED WITH STANDARD FUEL ELEMENTS. Vigil, John C. (Los Alamos Scientific Lab., N. Mex). Sept. 1967. Contract W-7405-eng-36. 15p. Dep. CFSTI.

Preliminary numerical calculations of the response of the Ultra High Temperature Reactor Experiment (UHTREX) (loaded with standard fuel elements) to a wide range of reactivity inputs are presented. These calculations were done in support of a proposed series of excursion experiments whose main purpose is to determine the adequacy of calculational methods presently being used and to identify areas where the methods may need improvement. The experiments would provide a test of the calculated fuel temperature coefficient in UHTREX and would contribute to the testing of nonseparable space-time neutron kinetics codes now being developed. These codes are needed for analysis of transients in UHTREX loaded with specially designed U-Th fuel elements and in other assemblies for transient studies in support of the High Temperature Gas-Cooled Reactor (HTGR) Program. (auth)

16156 (NP-17218) LA LOI AUTRICHIENNE SUR LA RESPONSABILITE CIVILE DANS LE DOMAINE DE L'ENERGIE NUCLEAIRE. (Austrian Law on Civil Responsibility in the Domain of Nuclear Energy). Moser, Berthold (Paris Univ. (France). Institut de Droit Compare). 1967. 11p. (In French). Dep.

General assignment of legal liability with regards to use of radioactive material according to Austrian law is discussed. Indemnification requirements are outlined; required guarantees are defined. Federal indemnification is outlined. Assignment of responsibility for casualties and incidents is detailed; definitions and requirements of persons or companies involved are given. (M.L.S.)

16157 (ORNL-4233) ZERO-POWER PHYSICS EXPERIMENTS ON THE MOLTEN-SALT REACTOR EXPERIMENT. Prince, B. E.; Ball, S. J.; Engel, J. R.; Haubenreich, P. N.; Kerlin, T. W. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 60p. Dep. CFSTI.

The techniques and results of a program of experiments designed to measure the important neutronic characteristics of the MSRE, under conditions of negligible nuclear heat generation are presented. The program includes the initial critical ^{235}U loading, the control-rod calibration (period-differential worth and rod drop-integral worth measurements), determinations of the reactivity loss due to fuel circulation, the "static" reactivity coefficients of excess ^{235}U concentration and isothermal core temperature, the fuel salt temperature reactivity coefficient, the pressure effects on reactivity, and a series of system dynamics tests (frequency response, transient flow, and neutron flux noise measurements). These measurements form much of the experimental baseline for current evaluation of the nuclear operation at full power. Discussions of the comparisons of the measurement results with the corresponding neutronic characteristics calculated from theoretical models are presented. (auth)

16158 (ORNL-NSIC-41) INDEX TO NUCLEAR SAFETY, A TECHNICAL PROGRESS REVIEW BY CHRONOLOGY, PERMUTED TITLE, AND AUTHOR VOL. 1, NO. 1 THROUGH VOL. 8, NO. 6. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 89p. Dep. CFSTI.

The index to Nuclear Safety is presented in three sections: (1) Chronological List of Articles, (2) Permuted Title Index, and (3) Author Index. (H.D.R.)

16159 (ORNL-TM-729(Pt.2A)) MSRE DESIGN AND OPERATIONS REPORT. PART IIA. NUCLEAR AND PROCESS INSTRUMENTATION. Tallackson, J. R. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 397p. Dep. CFSTI.

The considerations which influenced the MSRE Instrumentation and Control System design, particularly those which are unique or are peculiar to the MSRE, are discussed. The physical layout of the instrumentation system is described. A general description of the overall layout is given, and each area is described separately. The instrument systems are located by area, and the routing and installation of their interconnections are included. A broad, all-

inclusive picture of the entire MSRE instrumentation and control system, including control of auxiliary equipment and the instrument power system, is given. The "mode control" used to guide reactor operation is discussed with diagrams which define the conditions for the various modes (prefill, operate-start, operate-run). The safety-grade instrumentation and controls associated with the MSRE safety system are discussed. The discussion includes general design criteria illustrated by a typical system. The entire safety system, what it does, and why are tabulated and diagrammed. The instrumentation in the neutron channel up to, but not including, the panel electronics is shown. The neutron penetration, including the guide tube assembly, is described, and the interconnecting cabling, junction boxes, etc., associated with transmission of signals to the control rooms are diagrammed. Briefly described is the instrumentation associated with the sensitive BF_3 channels used for low-level flux measurement and control. The wide-range counting channels are described with block diagrams and an explanation of their operation. This is followed by descriptions of the chamber assembly, of the chamber and the associated electronic circuits, and of the electromechanical drive. Briefly described are the linear power channels and included are block diagrams and descriptions of the compensated ion chamber and of the picoammeter. A thorough description of the rod scram safety system is included. Block diagrams and circuit diagrams illustrate the discussion. The associated electronics are discussed in detail. A thorough description of the shim and regulating rod control system is given. Block diagrams and composite elementary circuit diagrams for both the servo rod and the shim rods are included. The "Confidence" interlocks originating in the wide-range counting channels are also described. The control rods and the rod drive units are described. A description of the pneumatic fiducial zero position indicator is included. The control of the equipment which determines the reactor load, namely: radiator, radiator doors, blowers, and bypass damper, is described in detail. Included are the health physics instrumentation and a general description of the individual types of instruments used plus a description of their interconnections to form an integrated alarm system. The components and electronics used to monitor process lines carrying helium, water, off-gas, etc., are described. Described is the radiation monitoring installed in the off-gas stack. The components, how they function, and their purpose are included in the discussion. A general description of the instrumentation in the various systems is provided. Included are descriptions of major control loops with drawings of individual control loops and their instrumentation. The principles of operation of the various components as well as control circuit operations are discussed. In general, sufficient descriptive material, augmented by flowsheets and diagrams, is included so that the arrangement and composition of the process instrumentation system can be determined. Introduced in very general terms are the types of electrical control and alarm circuits to be found in the MSRE system and how they are related. Described are the electrical control circuits with engineering elementary schematic circuits diagrams and included are the nonobvious interlock functions. The purpose and the physical construction of the jumper board are presented. Layout and wiring of a typical section of the board are included. The annunciator system is described. Considerations involved in the location of annunciators are outlined. Schematics of the annunciators used and their sequence of operation are included. Their operational use is also discussed. The system which provides the MSRE instrumentation, control circuits, and annunciators with the necessary power is outlined. Reliability considerations are included. A general description of the various types of standard instruments used in the MSRE and basic principles of their operation are included. Descriptions of the nonstandard instruments required by the MSRE are presented. Their unique or special features are outlined. A general, broad description of the data system is given. Described are basic capabilities, operations, and purpose of the logger-computer. The system of flow plan symbols and numbering used in preparation of instrument applications diagrams and tabulations is illustrated with typical examples. The system used in designing and identifying MSRE instrumentation and control wiring is described with typical examples of panel and interconnection wiring. Described is the system used in designing and identifying MSRE instrument tubing installations and included are a typical pneumatic schematic circuit and a typical panel and interconnection tubing installation. (auth)

16160 (PRWRA–118) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 9, September 1967. (Puerto Rico Water Resources Authority, San Juan). 16p. (WRA-B–67-19). Dep. CFSTI.

During September, 1967, the BONUS reactor was operated a short time in order to evaluate the shutdown margin, which resulted in agreement with the Technical Specifications limit, and the center rod worth which gave an average worth of $1.31. Then the reactor vessel head was removed and remained so for the rest of the month. An air leak test was performed on the superheater fuel assemblies and piping after the head removal operation revealed that elements 16B, C, and D outlet nozzles were leaking badly thru the "O" rings. 11A and D were leaking moderatly. No leaks were detected in the preheater piping. All control rods were inspected by means of the borescope. Small corrosion pits, scratches and tip wear were observed. No warping was noticed or detected in any rod. The reactor recirculation water flow reduction problem investigation continued. A hot test at 950 psig was performed by means of the electric preheater in order to determine the reactor circulating water pumps parameters. All parameters measured remained constant with no drifts during a ten days test. The recirculation flow reduction investigation will be continued. (auth)

16161 (TRG-Report–1343) THE PHYSICS AND CONTROL OF THE STEAM GENERATING HEAVY WATER REACTOR. A Revised Version of a Lecture Presented to the Federal Institute for Reactor Research on 3 November 1966. McMillan, R. N, H.; O'Dell, F. P.; Wray, D. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 45p. Dep. CFSTI. UK 6s.

Reactor physics methods used in the performance analysis of S.G.H.W. reactors with particular reference to the void coefficient of reactivity are described. The results of the experimental physics programme are summarized, which show that the likely error in the calculation of void coefficient on nuclear grounds is ±0.005. Further uncertainties in the distribution of voidage lead to the conclusion that the void coefficient for an operating reactor can be calculated to within ±0.01. The dynamic characteristics of the uncontrolled reactor, showing the important reactivity feedback effects, are described. The control system for the Winfrith S.G.H.W.R. is described and transients are presented to demonstrate the satisfactory performance within the expected range of void coefficients of the loops which control neutron flux, steam flow, steam pressure and feedwater flow. The equations which were used to represent the reactor, plant and control systems on a PACE analogue computer are also presented. The behavior of the system under grid frequency following operation is described, and the importance of the pressure feedback effects on the transient following a turbine load disconnection is discussed and means of keeping the reactor operational following this transient are given. (auth)

16162 (UJV–1860) XENONOVA STABILITA REAKTORU A2, CAST 2. (Xenon Stability of the A2 Reactor. Part 2). Blazek, J.; Krejci, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 72p. (In Czech). Dep.

In connection with the physical calculations of the active zone of a heavy water gas cooled natural U power reactor, the stability of Xe oscillations is investigated. A derivation of accurate difference equations describing the Xe oscillations considering the temperature effect is given. The equations are formulated for the azimuthal, axial, and radial modes; the coefficients are calculated on the GIER computer with the use of the 421 U program. The input data tape and print examples are given. The simulation on an analog computer enables determination of the stability region as well as the shape of particular oscillation modes. (27 references.) (auth)

16163 (WAPD-PWR-TE–204) INITIAL RADIATION SURVEY, SHIPPINGPORT ATOMIC POWER STATION, PWR PROJECT. Lau, Fred L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nov. 10, 1967. Contract AT(11-1)-Gen-14. 22p. Dep. CFSTI.

The second core for the Shippingport Atomic Power Station is designed for operation at 505 MW(th) which is about 2.2 times the design power for core 1. The results of an evaluation of the initial core 2 radiation survey of the Shippingport Atomic Power Station are presented. The radiation levels reported are primarily those which are present during plant operation. The test results show that there is no detectable neutron radiation outside of the external shield and that general gamma levels are less than 0.1 mrem/hr. Radiation levels inside the plant at shielded valve stations and in the reactor chamber after shutdown are also presented. (auth)

16164 (WCAP–2785) THE NUCLEAR DESIGN OF THE SENA REACTOR. Frank, F. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). May 1965. 124p.

SENA POWER REACTOR— core for, design and initial loading diagrams for; control rods for, reactivity worth of; void coefficient of reactivity for; shutdown reactivity coefficient for; xenon buildup in, determination of equilibrium concentration for; power distribution in, effects of core lifetime on; control rods for, hot channel factor determinations of; moderator tem-

perature coefficient in; neutron characteristics of, prompt and delayed
REACTOR FUEL ELEMENTS — design of Sena; temperature and power coefficients for
REACTOR CONTROL ELEMENTS — reactivity worths for Sena, differential and integral
XENON — buildup in Sena Power Reactor, determination of equilibrium concentration for
SAMARIUM — buildup in Sena Power Reactor, determination of equilibrium concentration for
BORON — use as chemical shim in Sena Power Reactor

16165 (WCAP-3696-6) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Quarterly Progress Report for the Period Ending December 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1968. Contract AT(30-1)-3696. 27p. (EURAEC-1952). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Progress on the experimental program to develop an understanding of the pH-reactivity effect observed in the operation of closed-cycle water reactors is described. An instrumented 3 × 3 fuel assembly and reactivity oscillator were installed in the Saxton reactor. The first series of pH-trip tests was conducted with the 3 × 3 assembly in a peripheral position. The test series consisted of reactor trip after reaching a steady state depletion rate, at high and low main coolant pH levels. Oscillator tests were conducted under steady-state conditions at high and low main coolant pH levels. (D.C.C.)

16166 (EURFNR-384) VARIATIONS IN CERTAIN MAJOR REACTOR PARAMETERS OF SODIUM-COOLED 1000 MWe FAST BREEDER, FOR INVESTIGATION INTO FUEL COSTS AND NEEDS. Benndorf, K.; Gupta, D.; Haefele, W.; Heusener, G.; Jansen, P. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-668. 19p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The economics of fast breeder reactors is discussed. Economic effects on parameter variation in breeder reactors are evaluated. Some features of carbide reactors are tabulated; oxide fueled characteristics are listed. Variation in plutonium price and in fabrication and reprocessing costs are given. (M.L.S.)

16167 (JPRS-44180) BASES OF FUTURE WORK IN NUCLEAR ENERGY. Moljk, Anton; Pop-Jordanov, Jordan; Vrhovac, Slavko. Translated from Nukl. Energ., 4: No. 4, 1-5(1967). 15p. CFSTI.

The status of Yugoslav efforts toward nuclear power plants is described. The formation and function of the Federal Nuclear Energy Commission (SKNE) is described. Long term economic considerations for selection of nuclear power plants is evaluated. (M.L.S.)

16168 MATERIALS FOR HIGH-TEMPERATURE NUCLEAR REACTORS. Goeddel, W. V.; Siltanen, J. N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Annu. Rev. Nucl. Sci., 17: 189-252(1967). (GA-7858).

The fuel element and related core materials development problems are reviewed for current and near-future high temperature reactors for civilian power applications. Fabrication, structural, and performance characteristics of graphite and coated-particle fuels for high-temperature gas-cooled thermal reactors are discussed. The factors involved in selecting fuel and cladding materials for fast breeder reactors are examined. Characteristics of carbide, oxide, and nitride fuels and high temperature cladding materials are reviewed. (H.D.R.)

16169 REPORT ON THE IAEA SYMPOSIUM ON INTERNATIONAL EXTRAPOLATION AND COMPARISON OF NUCLEAR POWER COSTS, LONDON, OCTOBER 9-13, 1967. Voelker, H. (Steinkohlen-Elektrizitaet AG, Essen). Atomkernenergie, 13: 72-6(1968). (In German).

Overall problems of cost extrapolation for nuclear power plants is discussed. Generating cost is shown as a function of load factor; cost comparisons are made between conventional power plants, gas-graphite reactors, and light water reactors. Fuel utilisation is summarised for the Italian power stations; technical data for English strategies is given. The results of regression analyses for light water reactors in the US are tabulated. Cost data are given for different boiling water reactors; change in fuel cycle cost with reactor size is shown; reprocessing costs are given. Fuel cost variations for light water reactors and high temperature gas cooled reactors are shown as a function of U_3O_8 price. 21 references. (M.L.S.)

16170 MUEHLEBERG NUCLEAR POWER STATION OF THE BERNESE POWER COMPANY. Auer, W. P. Brown Boveri Rev., 54: 51-68(Feb.-Mar. 1967).

The second commercial nuclear power station to be erected in Switzerland will be built at Mühleberg west of Berne and is due to commence supplying power to the network of the Bernese Power Company in the autumn of 1971. It will be equipped with a General Electric boiling-water reactor and two Brown Boveri steam turbosets. Brown Boveri are acting as managing partner of the consortium entrusted with the construction of the power station on a turnkey basis. Thus they not only assume responsibility for engineering and manufacture of the steam turbosets, but also for the entire electrical equipment, the station auxiliaries and all buildings, together with the planning. The design, the main technical data and some of the essential components of this 300-MW station are described. (auth)

16171 THEORETICAL MODEL FOR DESCRIBING THE PEBBLE BED-FLOW BEHAVIOR IN A PEBBLE BED REACTOR. Bedenig, D. (Kernforschungsanlage, Juelich, Ger.). Nucl. Eng. Design, 6: 479-88(1967). (In German).

A theoretical model ("stream tube model") and characteristic functions are introduced to describe the flow behavior of an axisymmetric pebble bed. To show the validity of this model experimental data are compared with results of relevant computer calculations. (8 references.) (auth)

16172 INTERNAL STEAM SEPARATION SHOWN SUCCESSFUL IN GERMAN NUCLEAR PLANT. Robbins, C. H. (General Electric Co., San Jose, Calif.). Elec. World, 168: 71-2(July 24, 1967).

The internal steam separation equipment in the Gundremmingen nuclear power plant is described. The separators are multiple units of the vertical axial flow centrifugal type. The dryers are the Peerless hook-vane type. (H.D.R.)

16173 THE PLANNING FOR THE FUKUSHIMA POWER STATION. Nomura, Akio (Tokyo Electric Power Co., Inc.). Karyoku Hatsuden, 18: 541-50(June 1967). (In Japanese).

A description is given of the 460 MW(e) BWR-type Fukushima power plant in the following sections: an outline of the power station (the site, and the planning for the plant and facilities); the reactor and facilities; the turbines and facilities; the electrical facilities; the instrumentation and control; the reactor containment; and the waste-disposal facility. (NSA of Japan)

16174 THE PLANNING FOR THE MIHAMA POWER STATION. Okano, Shigeo Karyoku Hatsuden, 18: 551-61(June 1967). (In Japanese).

Kansai Power Company decided to construct its atomic power station in Fukui Prefecture, in November 1962, and a PWR to be its first power plant in April 1966. The outline of the reactor is as follows: the heat output 1,031 MW(t); the coolant temperatures at the inlet and outlet, 294° and 322°C, respectively; the fuel UO_2 with maximum temperature 2,150°C; the cladding Zircaloy-4; the control Ag-In-Cd alloy; the pressure vessel with design pressure 175 kg/cm² G and design temperature 343°C. A description is given in the sections: the course to the final decision of power-station construction; the proceedings for purchase, and decision of the reactor type; an outline of the design of the first reactor plant (reactor and its core, control-rod clusters, the reactor auxiliary facilities, the engineering safety-measures, and the anti-earthquake design); the safety inspection; and an outline of the construction schedule. (NSA of Japan)

16175 GAS CIRCULATORS IN THE ST. LAURENT I NUCLEAR POWER STATION OF ELECTRICITE DE FRANCE. Feer, K.; Benz, H. Sulzer Tech. Rev., 49: 79-89(1967).

The fourth and sixth nuclear power stations of Electricité de France, with net outputs of 480 MW, are each equipped with four Sulzer circulating blowers. In view of the integrated design blowers of the mixed flow type with radial diffuser discharge are most suitable. In the development of these machines many components had to be proved with model tests to ascertain that they were fully equal to the strength and functional requirements placed on them. An aerodynamic model enabled the blower characteristics to be measured and the performance guarantee trails to be carried out. (auth)

16176 SULZER MONOTUBE STEAM GENERATOR FOR THE NUCLEAR POWER STATION ST. LAURENT I OF ELECTRICITE DE FRANCE. Kagi, J. Sulzer Tech. Rev., 49: 65-77(1967).

Integrated configurations in French reactor design with prestressed concrete vessels, Sulzer boiler and circulators for the

EDF-4 station are discussed. Design of the steam generator modules, thermodynamic conception, project work, production and erection are outlined. (auth)

16177 COMPUTER CONTROL OF THE HBWR. Lunde, J. E. Atoomenergie Haar Toepass., 9: 267-73(Dec. 1967).

The main features of the Halden Boiling Water Reactor on-line process control computer system are described. A development program for the intended control functions of the system, including reporting and monitoring, steady-state power and pressure control, external circuit control, evaluation and control of core-power distribution, operational condition changes, and startup and shutdown control, is discussed. (H.D.R.)

16178 NEW AEC GUIDE SIMPLIFIES TECH SPECS. Rhode, Gerald K. (Niagara Mohawk Power Corp., Buffalo). Power, 111: 125-7(Dec. 1967).

Changes in AEC regulation activities, which are concerned with 10 CFR Part 50, are outlined. The revised guide for technical specifications is condensed and presented in tabular form. This guide is then evaluated from a view of experience at Niagara Mohawk's Nine Mile Point Nuclear Station. (M.L.S.)

16179 OPTIMUM COMPRESSION DEGREE OF THE GAS TURBINE CYCLE IN NUCLEAR POWER PLANTS. Danila, N.; Grecov, D. Rev. Roum. Sci. Tech., Ser. Electrotech. Energ., 12: 87-97(1967).

The value of the optimum degree of compression in the case of a nuclear power station equipped with gas turbine installations is analyzed as a function of the following factors: maximum temperature of materials inside the nuclear reactor, turbine inlet gas temperature, recovery rate of the cycle, and turbine and compressor relative efficiency. Computation formulas have been obtained thereby making it possible for the optimum value of the compression degree in gas turbine installations to be approximated. (auth) (Rom. Sci. Abstr.)

16180 FAST REACTORS NATIONAL TOPICAL MEETING, SAN FRANCISCO, CALIFORNIA, APRIL 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967. 606p. (CONF-670413-(and Suppl.)). DTIE.

Separate abstracts are prepared for 29 of the 31 papers presented. For the paper on "Operation of the Plutonium-Fueled Fast Reactor LAMPRE" see NSA 21: 30155; for the paper on "The Conceptual Evaluation of a Fast Flux Test Facility" see NSA 21: 25619. (M.L.S.)

For abstracts of individual papers see: 16181–16208 and 16330.

16181 EBR-II OPERATING EXPERIENCE. Novick, M.; Bacca, J. P.; Cerutti, B. C.; Cissel, D. W.; Kirn, F. S.; Smith, R. R.; Whitham, G. K. (Argonne National Lab., Idaho Falls, Idaho). pp 1.1-20 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

ERB-II has been operating routinely and very satisfactorily as a sodium cooled fast breeder power demonstration reactor while serving as a fast flux irradiation facility in the AEC's LMFBR program. Approximately 340 candidate specimens of interest to this program have undergone irradiation by the end of 1966. Reprocessing and refabrication in the adjacent Fuel Cycle Facility of all driver fuel has been highly successful. Although a total of over 24,000 fuel elements has undergone irradiation in the reactor, no failure of any one has been evident. Some of the fuel in the reactor is now in its third cycle of operation through the Fuel Cycle Facility and reactor. Physics experiments and measurements have been carried out on a continuing basis to provide assurance that the changes in the kinetic character of the reactor due to its inclusion of experimental irradiation subassemblies has not affected its safety. Performance of the driver fuel has been less than expected and has resulted in a conservative restriction being placed on burnup limits and the initiation of an improved driver fuel development program. No failure of any major reactor components has been experienced and considerable experience has been obtained in the operation and performance of the reactor plant system and its components. 11 references. (auth)

16182 ENRICO FERMI ATOMIC POWER PLANT OPERATING EXPERIENCE THROUGH 100 Mwt. Alexanderson, E. L. (Power Reactor Development Co., Detroit); Branyan, C. E.; Ford, J. A.; Nims, J. B.; Olson, W. R. pp 1.21-45 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Operating experience of the Fermi Fast Breeder through 200 MW(t) is outlined. Operating statistics are tabulated; results of the high power nuclear test program are given. Transfer function measurements are discussed; transient testing results are tabulated. Heat balances are given for all systems at 100 MW(t); core and blanket temperature measurements are described; primary sodium and cover gas impurity analyses are tabulated. Plant performance at power is discussed in some detail. 9 references. (M.L.S.)

16183 INVESTIGATION OF THE FUEL MELTING INCIDENT AT THE ENRICO FERMI ATOMIC POWER PLANT. Duffy, J. G. (Atomic Power Development Associates, Inc., Detroit); Jens, W. H.; Feldes, J. G.; Johnson, K. P.; McCarthy, W. J. Jr. pp 2.15-37 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A detailed summary of October 4–5, 1966, operation of the Fermi Fast Breeder is given. The summary begins with approach-to-critical on October 4 and follows through, stepwise, to final manual scram on October 5, 1966, the final scram decision being dictated by high radiation alarms and subsequent isolation of the fission product detector building and containment building. Plant investigations after October 5, 1966, are outlined. Plant systems are analyzed for October 5; a temperature analysis is given; reactivity and power histories are shown as they vary with hour of the day. Results of primary Na and Ar analyses are tabulated; fourteen causes of fuel meltdown are postulated. The design of new fuel handling and inspection equipment is discussed. (M.L.S.)

16184 THE CONTRIBUTION OF EVESR OPERATION TO FAST STEAM COOLED REACTOR DEVELOPMENT. McEwen, L. H.; Hubbard, E. T.; O'Neill, G. L.; Schneider, H. J. (General Electric Co., Pleasanton, Calif.). pp 2.39-44 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Operation of the EVESR plant, a 17 MWt steam-cooled, thermal-neutron-spectrum reactor, has provided a great deal of information applicable to steam-cooled, fast-neutron-spectrum reactors. More than 500 fuel rods clad with materials being considered for steam-cooled fast reactor fuel have been irradiated in a superheated steam environment. Long-continued operation of the facility with fuel containing intentional cladding penetrations, as well as with fuel which developed leaks in service, proved feasible; however, in some cases it proved desirable to adjust operating conditions to reduce fission product leakage from fuel. Steam-borne transport of radioactive materials from the reactor to the power extraction portion of the plant was such that the radiation levels encountered in maintenance activities did not create severe problems. Techniques were developed to cope with operational nuisances such as steam leaks, and highly successful methods were demonstrated for the control of off-gases bearing radioactive materials. From an operational standpoint, steam-cooled fast reactors should be quite similar to the EVESR plant, and its highly successful operation would indicate the steam-cooled fast reactor concept to be one of great promise. (auth)

16185 SRE AND HNPF OPERATING AND MODIFICATION EXPERIENCE. Woodruff, R. W.; Durand, R. E.; Owens, J. E. pp 2.45-61 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

The Sodium Reactor Experiment (SRE) and the Hallam Nuclear Power Facility (HNPF) are sodium-cooled graphite moderated reactors. They were designed and constructed to demonstrate feasibility of the Sodium-Cooled-Graphite-moderated reactor concept, and in so doing, they helped solve many of the problems faced by Na-cooled fast breeders. The systems external to the reactor core have many features in common with fast breeders. The main heat transfer system, the purification systems, and the auxiliary systems associated with both reactors performed well, though not without problems. 23 references. (auth)

16186 ATOMICS INTERNATIONAL DEMONSTRATION FAST BREEDER REACTOR. Dieckamp, H. M.; Beeley, R. J.; Stoker, D. J.; Ash, E. B. (Atomic International, Canoga Park, Calif.). pp 3.1-22 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A 500 Mwe Na-cooled fast breeder reactor conceptual design to establish the basis for early demonstration plant operation is described. The conceptual design being obtained by systematically

examining alternate system and subsystem choices is given; cost effective techniques wherein capital, fuel and development costs, prior experience, maintainability and reliability are evaluated. Major system evaluations have been or are being conducted relative to basic plant operating parameters, core geometry, primary system configuration, fuel handling and steam generators, as well as overall plant design and layout. Plant hardware selections to date include a double rotating plug fuel handling system with external fuel handling machines; a modular straight shell and tube steam generator; and free surface Na pumps for both primary and secondary loops. Many of the engineering considerations incorporate the experience gained from SRE, Hallam and other Na component development programs. (M.L.S.)

16187 NA-2 DESIGN: 300 MWe GERMAN FCR. Gast, K. (Kernforschungszentrum Karlsruhe, Ger.); Schlechtendahl, E.; Smidt, D.; Guthmann, E.; Held, C.; Koehler, M.; Morgenstern, F. pp 3.23-38 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

Preliminary results of the current conceptual design study for a 300 MWe Na cooled fast breeder reactor are presented. Due conservatism is applied in the design and in the safety assessment to account for the first-of-a kind-characteristic of the 300 MWe reactor. This guideline leads to a reactor concept, which does not fully utilize the economic potential of sodium cooled fast breeder reactors and may not even be typical of large future power plants in all respects. It does, however, include most of the basic features previously established for large commercial breeder reactors. Those design features which are of vital importance to the safety and operating reliability of the reactor are discussed. Emphasis is laid upon the critical design aspects of the core and of the primary coolant system. Regarding the design basis accident, consequence limiting safeguards are described in some detail. (auth)

16188 THE PHENIX REACTOR. Carle, R. (CEA, Paris); Faure, J.; Leduc, J.; (and others). pp 3.39-59 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

The Phenix reactor, its main features and major components are described. Designed for 250 MWe, Phenix will be a sodium cooled prototype reactor loaded with UO_2-PuO_2, the primary cooling systems being inside the reactor vessel. (auth)

16189 PRELIMINARY WORK ON A 300-MW FAST CERAMIC DEMONSTRATION REACTOR. Wolf, B.; Clabaugh, W. J. (General Electric Co., Sunnyvale, Calif.). pp 4.1-23 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

General features of a prototype reference design for a 300 MW(e) fast ceramic reactor are discussed. Safety considerations are presented; reactor physics parameters are tabulated. Fuel isotopic compositions for an equilibrium cycle are presented; reactor operating parameters are listed. Layouts of system flow, sodium systems, and the reactor building are shown. The various systems are discussed briefly. 16 references. (M.L.S.)

16190 THE GAS-COOLED FAST-REACTOR EXPERIMENT. Fortescue, P.; Broido, J.; Schultz, G.; Shanstrom, R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 4.25-38 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

Design parameters for the gas-cooled reactor experiment are given. Cutaways of the PCRV, fuel handling facilities, grid plate, orifice, fuel support, and fuel assemblies are shown; each is discussed briefly. A complete set of design parameters is tabulated. (M.L.S.)

16191 SEFOR PLANT DESIGN. Billuris, G.; Hikido, K.; Olich, E. E.; Reynolds, A. B. (General Electric Co., Sunnyvale, Calif.). pp 5.1-30 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

The Southwest Experimental Fast Oxide Reactor (SEFOR) is a 20-MW(t), ceramic-fueled, sodium-cooled, fast flux reactor. SEFOR is intended to provide data in support of a test program to demonstrate that fast ceramic power reactors can be designed with desirable operating and safety characteristics. Design of this facility is essentially complete; all major components have been ordered or procured. Field installation is progressing, with construction scheduled for completion early in 1968. The SEFOR plant design is reviewed, and some of the problem areas encountered during the design are described. Design data and descriptive information are presented for the reactor vessel and internals, reactor control, sodium and cover gas systems, shielding, and refueling facilities. SEFOR safeguard considerations are discussed. 8 references. (auth)

16192 SEFOR PREOPERATIONAL DEVELOPMENT PROGRAM. Horst, K. M. (General Electric Co., Sunnyvale, Calif.). pp 5.31-54 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

The experimental program for SEFOR development is presented. Core clamping tests, core flow tests, fuel irradiation and expansion experiments, and ZPR-III critical experiments are discussed briefly. Developmental work on thermocouples, magnetic flowmeters, and a transient power detecting system is outlined. Fuel handling tests are described. 19 references. (M.L.S.)

16193 RAPSODIE DEVELOPMENT PROGRAM: FROM DESIGN TO OPERATION. Bussy, P.; Denielou, G.; Gajac, G.; Guillet, H.; Labat, P.; Pontier, R.; Rozenholc, M.; Vautrey, L.; Zaleski, P. (CEA, Paris). pp 5.55-75 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

An historical account of the design and construction of Rapsodie is presented. Construction costs are broken down into units which are: reactor vessel and mechanisms, fuel handling, sodium-argon circuits, control, and civil engineering. The testing program is delineated; intended use is discussed. Design parameters and operating conditions for the reactor and reactor systems are given. (M.L.S.)

16194 MAIN TECHNICAL PROBLEMS RAISED BY THE CONSTRUCTION AND TESTING OF RAPSODIE. Chapelot, A. (CEA, Paris); Chauvin, M.; Delisle, J. P.; Denielou, G.; Gollion, H.; Grandcolas, J.; Reynes, L. pp 6.1-13 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

Problems associated with the construction and testing of Rapsodie are summarized. Use of mockups is discussed; quality and dimensional control are outlined. Mechanical problems associated with high temperature low pressure piping of liquid sodium are given; pressure control for the argon cover gas system is discussed. The fuel handling machine and its associated problems are outlined. Sodium purification is discussed briefly. (M.L.S.)

16195 STATUS OF THE UKAEA PROTOTYPE FAST REACTOR. Frame, A. G. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 6.15-36 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

The design of the Prototype Fast Reactor is discussed. The core and breeder are described briefly; the primary coolant circuit is detailed; the steam generating plant is discussed. Safety considerations are outlined; a construction summary is given. Descriptive diagrams for all systems are shown. (M.L.S.)

16196 CONSTRUCTION AND DESIGN PROBLEMS OF SODIUM COOLED FAST REACTORS. Leonard, B. H. Jr.; Plawchan, J. D. (Bechtel Corp., San Francisco). pp 6.37-43 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

Effects of coolant properties on construction of Na-cooled fast reactors are outlined. Problems with plant design features are reviewed. The importance of quality assurance is discussed. (M.L.S.)

16197 CONSTRUCTION AND DESIGN PROBLEMS OF SODIUM COOLED FAST REACTORS. Bergstrom, R. N.; Chittenden, W. A.; McClintock, D. C. (Sargent and Lundy, Engineers, Chicago). pp 6.45-56 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

Representative examples of design developments for Na cooled fast reactors include: analysis of complex irregular reinforced concrete structures, which contain many discontinuities and penetrations and which are designed to withstand internal pressures

that are accompanied by significant temperature changes; the anchorage and expansion of steel liners to withstand high temperature transients; analysis and design of piping systems which will accommodate large temperature differentials while imposing exceptionally low forces and moments on equipment terminals; vessel penetration details for power and instrumentation leads for equipment within the high radiation and high temperature levels. The effects of each of these on design and construction of Na cooled fast reactors are considered. (M.L.S.)

16198 STATUS OF THE TECHNOLOGY OF GAS COOLING FOR FAST REACTORS. Fortescue, P.; Melese-d'Hospital, G.; Thompson, W. I. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 7.1-12 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Choice of coolants for gas-cooled fast reactors is treated briefly. Performance characteristics of a He cooled reactor are given for two temperatures. A comparison of fast and thermal gas cooled reactors is made. A summary of gas cooled reactors operating, under construction, or planned is tabulated. Circulators, prestressed concrete reactor vessels (PCRV), steam generators, and fuel elements for high temperature gas cooled reactors are discussed. 30 references. (M.L.S.)

16199 THE SWEDISH FAST REACTOR PROGRAM STEAM COOLED REACTOR STUDIES. Hannerz, K. (Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden); Ekholm, R.; von Bonsdorff, M. pp 7.13-29 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A discussion of the design basis for fast light water steam cooled reactors is given. A consideration of the use of heavy water steam for improvement of breeding performance is discussed. The core design basis for steam cooled reactors is described with emphasis on fuel pin behavior and the effect of steam pressure on the cladding. System design studies for fuel cycle performance are outlined. Stability limits for a fast light water steam reactor are shown. Safety of the overall plant is discussed. 21 references. (M.L.S.)

16200 STATUS OF STEAM COOLED FAST REACTOR TECHNOLOGY. Leitz, F. J.; Murphy, P. M.; Pluta, P. R.; Rubinstein, H. J. (General Electric Co., Sunnyvale, Calif.). pp 7.31-9 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A broad base of steam cooled reactor technology is available from the extensive development programs and successful operation of thermal water reactors and nuclear superheat reactors, in particular EVESR. A substantial fund of complementary fast reactor technology also has been, and is being, developed especially in the area of mixed oxide fuel and reactor physics. To further establish the technological foundation for fast steam cooled reactors, a comprehensive development program is planned centered around a 50 MWe Experimental Steam Cooled Reactor. 11 references. (auth)

16201 THE GERMAN STEAM-COOLED FAST BREEDER PROGRAM. Fischer, J.; Kirchenmayer, A. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 8.1-9 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

The prototype design for a German steam cooled fast breeder reactor is discussed. Fuel element and component development is outlined; layouts are given for primary coolant and steam generation systems. (M.L.S.)

16202 THE DEVELOPMENT STATUS OF URANIUM–PLUTONIUM MONOCARBIDE FUEL PINS FOR THE LMFBR. Ray, W. E.; Biancheria, A.; Jacoby, W. R. (Westinghouse Electric Corp., Cheswick, Pa.). pp 8.11-23 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Selection of cladding materials for the liquid metal fast breeder reactor is discussed; qualitative comparisons are given for some materials. Physical properties of UC–PuC carbide fuel materials are tabulated. Data on radial burnup and swelling rates are presented. A conceptual fuel element design is presented. 28 references. (M.L.S.)

16203 SUMMARY OF THE STATE OF TECHNOLOGY: SODIUM PUMPS. Dall, R. E.; Plapp, D. P. pp 8.25-33 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

The technology of large centrifugal sodium pumps is discussed. Reliability of mechanical seals, dry gas seals, and bearings is evaluated. The pumping unit is described. Design predictability is discussed briefly. (M.L.S.)

16204 SUMMARY OF SCTI EXPERIENCE. Dickinson, Robert W.; Leppard, J. A. (Atomics International, Canoga Park, Calif.). pp 8.35-42 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A description of the Sodium Components Test Installation is given. Problems encountered in its operation are discussed. The operations history is outlined. (M.L.S.)

16205 DESIGN PHILOSOPHY FOR THE WESTINGHOUSE PROTOTYPE FAST BREEDER REACTOR. Wright, J. H.; DeHuff, P. G.; Graves, H. W.; Tower, S. N. Paper-1(28p.) of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Special design features of the Westinghouse breeder demonstration reactor and plant are discussed. A cross sectional view of the core is presented; core parameters are listed. Design data for the prototype intermediate heat exchanger are given. Characteristics for primary and secondary pumps are given; specifications for the sodium steam generator are listed. (M.L.S.)

16206 STEAM GENERATORS: SUMMARY OF THE STATE-OF-TECHNOLOGY. Jones, R. H.; Probert, P. B. Paper-2(16p.) of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Various types of steam generators for the liquid metal cooled fast breeder reactor are analyzed. Operating characteristics of the ALCO/BLH, AI, and Band W prototype steam generators are tabulated; cross sections of each are shown. (M.L.S.)

16207 THE P.E.C. REACTOR. (A FUEL TEST FAST REACTOR). Pierantoni, F.; Fogagnolo, G.; Zona, R.; (and others). (CNEN, Bologna). Paper-3(65p.) of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

A general description of the PEC reactor is given. Details concerning the power distribution, control rods, and reactivity coefficients for cermet and oxide fuels are outlined. Dynamic characteristics of the core are given; the neutronic shield is discussed. Fuel cycle evaluations are detailed. (M.L.S.)

16208 OBJECTIVES AND DIRECTIONS FOR FAST REACTOR DEVELOPMENT. Cohen, Karl (General Electric Co., Sunnyvale, Calif.). Paper-4(9p.) of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413-(and Suppl.).

Objectives and direction of fast reactor development are outlined. Economic factors are considered; availability of natural resources is evaluated. Use of plutonium as fuel is emphasized. (M.L.S.)

16209 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE. VOLUME XXIX. Proc. Amer. Power Conf., 29: 1-1149(1967). (CONF-670444-(Vol.29)).

Included are 119 papers on the broad overall aspects of the generation, transmission, distribution, and utilization of power. Separate abstracts were prepared for 23 papers on the development, economics, and applications of nuclear energy for power production. One paper was previously abstracted and appears as NSA 21:42777. (H.D.R.)

For abstracts of individual papers see: 16210–16232.

16210 CAN COAL MEET THE NUCLEAR CHALLENGE? LeClair, Titus G. (General Dynamics Corp., San Diego, Calif.). Proc. Amer. Power Conf., 29: 4-11(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

Economic factors involved in the trend toward installation of

nuclear units by the electric utility industry are discussed. Capital costs are compared for coal-fired and nuclear plants. Nuclear units are becoming more competitive in capital cost per kilowatt as the effects of load growth, power pooling, and strong interconnections are enabling the utilities to go to larger units. Fuel cost and supply factors are compared for nuclear and coal-fired units. A moderate rise in the delivered price of coal is predicted for the next few years, while nuclear fuel-cycle costs should decrease as advanced converter and fast breeder reactors are developed. (H.D.R.)

16211 ADVANCED REACTORS DEVELOPMENT IN THE EUROPEAN COMMUNITY. Gueron, Jules (European Atomic Energy Community, Brussels). Proc. Amer. Power Conf., 29: 53-7(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The advanced converter reactor projects under development in the European Atomic Energy Community are tabulated and discussed. (H.D.R.)

16212 CANADA'S PLANNED ADVANCED REACTOR CONCEPTS. Lewis, W. Bennett. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Proc. Amer. Power Conf., 29: 57-62 (1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The Canadian development of natural-uranium heavy-water-moderated reactors (CANDU-type) is reviewed and fuel costs are compared with costs for other reactor types. The economics of the "stretch" concept, or expansion of power station capacity beyond the original design, are discussed. (H.D.R.)

16213 THE UNITED KINGDOM PROGRAM ON ADVANCED REACTOR CONCEPTS. Mummery, P. W. (United Kingdom Atomic Energy Authority, Risley, Eng.). Proc. Amer. Power Conf., 29: 63-70(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The United Kingdom Nuclear Power Program for central station electricity generation is reviewed, and the Magnox reactors of the first phase and AGR reactors of the second phase are tabulated. The third phase development of fast reactors is discussed, and economic factors are examined. A forecast of the total and nuclear generating capacity in Great Britain is presented. (H.D.R.)

16214 DEVELOPMENT IN THE UNITED STATES. Shaw, Milton (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf., 29: 70-88(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

Nuclear power plants operating, under construction, or on order in the United States are tabulated. The trend of the rapid growth pattern for power reactors is examined, and reactor concepts under development and concepts planned for future development are assessed. The liquid-metal fast breeder reactor program objectives and efforts to date are described in detail. (H.D.R.)

16215 NUCLEAR POWER PLANT OF TVA AT BROWNS FERRY: BACKGROUND AND DESCRIPTION. Parrish, J. R. (Tennessee Valley Authority, Knoxville); Roy, G. M.; Baily, F. G. Proc. Amer. Power Conf., 29: 102-15(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The 1100 MW(e) Browns Ferry Nuclear Power Plant to be constructed on the Wheeler reservoir in Alabama is described. The plant layout, nuclear system, and turbine-generator system features of the twin boiling water reactor units scheduled for startup in 1970 are presented. (H.D.R.)

16216 UNIQUE ASPECTS OF THE SAN ONOFRE NUCLEAR PLANT. Baskin, K. P. (Southern California Edison Co., Los Angeles); McEntee, J. R.; Dietz, J. F.; Von Hollen, H. J. Proc. Amer. Power Conf., 29: 116-25(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The 430 MW(e) San Onofre Nuclear Generating Station is located on the Southern California coast within the Camp Pendleton Marine Corps Reservation. Some of the more unique aspects of the pressurized water reactor plant design, plant licensing, station personnel and training, and the startup program are described. (H.D.R.)

16217 THE FORT SAINT VRAIN HTGR. Habush, A. L. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Walker, R. F. Proc. Amer. Power Conf., 29: 126-34 (1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The conventional and nuclear plant features of the high-temperature gas-cooled system to be used in the 330 MW(e) Fort St. Vrain Nuclear Generating Station are described. The reactor incorporates a prestressed concrete reactor vessel, utilizes coated-particle fissile and fertile fuels, and is expected to have a net plant efficiency of almost 40%. (H.D.R.)

16218 DESIGN AND CONSTRUCTION OF MULTIPLE-UNIT NUCLEAR POWER PLANTS. Hoveke, G. F. (Sargent and Lundy, Inc., Chicago); Rabenold, C. F.; McDaniel, D. Proc. Amer. Power Conf., 29: 135-43(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The many savings and advantages that are available in the areas of design, licensing, procurement, and construction of multiple-unit nuclear plants are described. These advantages are illustrated by an examination of the design and construction aspects of Dresden Nuclear Power Station, Unit 2 and Unit 3, and Quad-Cities Station, Unit 1 and Unit 2. (H.D.R.)

16219 ECONOMIC IMPACT OF BREEDER REACTORS ON UTILITY SYSTEMS. Wright, J. H.; Smith, E. E.; Nordman, D. A. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 29: 144-56(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The alternative utility system expansion patterns are analyzed, beginning in 1986 and extending for 20 years. Water reactors dominate the present trend to nuclear power in the utility industry and will continue to do so for many years. This establishes the pattern for uranium requirements, and the key parameters of the analysis of expansion patterns are uranium supply and demand. The economic importance of high-gain breeders, low-gain breeders, and steam-cooled breeders to protect the savings achieved by water reactors and as another increment of savings are evaluated for the 20 year period. Results show the high-gain breeder can best accomplish both goals. (H.D.R.)

16220 ENGINEERING CONSIDERATIONS OF FAST BREEDER REACTOR PLANTS. Balent, Ralph; Golan, Simcha (Atomics International, Canoga Park, Calif.). Proc. Amer. Power Conf., 29: 157-76(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

Engineering aspects and development efforts are discussed for the liquid sodium-cooled fast breeder reactors in the United States. Anticipated performance data for first generation breeders are tabulated. The reactor, heat transfer system, and turbine plant design and performance are presented for a conceptual 500 MW(e) demonstration plant. (H.D.R.)

16221 A 1000-MWe GAS-COOLED FAST BREEDER REACTOR. Fortescue, P.; Schultz, G. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Proc. Amer. Power Conf., 29: 178-88(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The advantages of gas cooling for fast reactors to increase system performance and plant availability over that attainable in liquid metal cooled systems are considered. The steam supply system, turbine-generator plant, nuclear characteristics of the reactor, and anticipated power plant performance are described for a 1000 MW(e) gas-cooled fast breeder reference design. (H.D.R.)

16222 THE SEFOR PROJECT: ITS SIGNIFICANCE AND PROGRESS. Wolfe, Bertram (General Electric Co., Sunnyvale, Calif.). Proc. Amer. Power Conf., 29: 189-201(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The Southwest Experimental Fast Oxide Reactor project is a 20 MW(t) fast sodium-cooled reactor utilizing ceramic fuel. The major goals of the SEFOR project are to provide experimental information on the Doppler effect and operating characteristics of large, fast, ceramic breeder power reactors. The SEFOR design and experimental program are described. (H.D.R.)

16223 SYSTEM PLANNING ASPECTS AND ECONOMIC FACTORS. Caldwell, W. E. (Consolidated Edison Co., New York). Proc. Amer. Power Conf., 29: 202-6(1967).
From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The increase in power demand, site considerations, economic factors, and public reception indications that resulted in the

decision to construct the 873 MW(e) Indian Point Nuclear Generating Station, Unit 2, are presented. (H.D.R.)

16224 OVERALL PLANT DESIGN. Dierman, H. W. (Consolidated Edison Co., New York); Russo, H. L.; Thompson, W. R. Proc. Amer. Power Conf., 29: 206-18(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The building layout, plant seismic design, reactor design, turbine-generator system, condensers, feedwater cycle, feed pumps and drives, and electrical systems are described for the Indian Point Nuclear Generating Station, Unit 2. (H.D.R.)

16225 SITING AND LICENSING CONSIDERATIONS. Cahill, W. J. Jr. (Consolidated Edison Co., New York); Beckjord, E. S.; Nichols, R. C. Proc. Amer. Power Conf., 29: 218-26(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The geology, meteorological conditions, and population densities of the Indian Point, Unit 2 site are briefly reviewed. The consequence-limiting engineered safeguards of the plant are described, including the containment vessel, emergency core cooling system, containment cooling system, and fission product cleanup system. (H.D.R.)

16226 NUCLEAR STEAM SUPPLY SYSTEM. Haga, P. B. (Westinghouse, Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 29: 227-36(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The fluid systems needed for the generation of steam to drive the main turbogenerator of the Indian Point Unit 2 power plant are described. Improved features and performance of the reactor coolant system and chemical and volume control system are discussed. (H.D.R.)

16227 FINANCIAL ASPECTS OF THE NUCLEAR FUEL CYCLE. Povejsil, D. J.; Witzke, R. L.; DeSalvo, C. A. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 29: 237-49(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The individual steps in the nuclear fuel cycle and the form and quantity of nuclear material required in each step are described. Fuel-cycle descriptions and costs are based on the characteristics of pressurized-water reactor types, but are generally applicable to all commercially available light water reactors. The physical description of the fuel cycle is presented, and the underlying costs of materials and services and their timing requirements are outlined. From these data, the cost of each step in the cycle is derived, and the capital needs of the cycle are calculated. The step costs and working capital costs are combined to obtain total working capital requirements of a large nuclear plant. (H.D.R.)

16228 SHOP FABRICATION AND QUALITY CONTROL TECHNIQUES FOR MASSIVE NUCLEAR VESSELS. Fragomen, A. T. (Babcock and Wilcox, Barberton, Ohio). Proc. Amer. Power Conf., 29: 263-71(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The design, fabrication, and quality control of the massive steel pressure vessels for nuclear reactors require rigid manufacturing techniques to ensure reactor vessel safety. Nine essential factors necessary to the successful fabrication and control of nuclear vessels are examined. These factors are: design, material selection, manufacturing engineering, production control, plant facilities, tooling, shipping and traffic control, work force, and quality control. (H.D.R.)

16229 PREDICTING THE PERFORMANCE OF LARGE STEAM TURBINE-GENERATORS OPERATING WITH SATURATED AND LOW SUPERHEAT STEAM CONDITIONS. Baily, F. G.; Cotton, K. C.; Spencer, R. C. (General Electric Co., Schenectady, N. Y.). Proc. Amer. Power Conf., 29: 272-9 (1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

The need for a nuclear turbine performance prediction method is delineated, and the derivation of the major efficiency curves comprising the method is described. The nature and magnitudes of moisture related losses and consideration of these losses in the development of expansion line efficiencies are discussed, and the gains available through moisture reduction are reviewed. Application of the method to typical nuclear turbine-generator cycles is outlined. (H.D.R.)

16230 TURBINES AND CYCLES FOR NUCLEAR POWER PLANT APPLICATION. Artusa, F. A. (Westinghouse Electric Corp., Lester, Pa.). Proc. Amer. Power Conf., 29: 280-94 (1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

Considerations in the design of economic saturated steam cycles for present-day light water power reactors are examined. Saturated steam cycles employing either reheat or nonreheat to reduce low-pressure end point moisture and improve turbine heat rate are discussed. Turbine designs available for operation with saturated steam cycles are described. (H.D.R.)

16231 CYCLES FOR STEAM-COOLED POWER REACTORS USING THE LOEFFLER CONCEPT OF STEAM GENERATION. Streeton, Derrick F. (Suiselectra AG, Basel). Proc. Amer. Power Conf., 29: 295-304(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

Steam cycle arrangements which could be applied to steam-cooled reactor power stations are discussed. The most logical primary steam cycle for a reactor of this type is one using the Loeffler principle. The operating principle is described, and variations on the cycle, including straight cycle, direct reactor reheat cycle, indirect reheat cycle with condensing reheater, indirect reheat cycle with noncondensing reheater, and combined reheat dual-pressure cycle, are examined. (H.D.R.)

16232 NUCLEAR ENERGY FOR INDUSTRIAL HEAT AND POWER SUPPLIES. Decker, G. L. (Dow Chemical Co., Midland, Mich.); Butler, W. S.; Wilson, W. B.; Bigge, W. B. Proc. Amer. Power Conf., 29: 305-15(1967).

From 29th Annual Power Conference, Chicago. See CONF-670444-(Vol.29).

In the past, the industries having a large requirement for process heat have found it economical to generate byproduct power. The relative economics of fossil and nuclear plants to supply process industry heat and power are examined by comparison of three large fossil plant configurations with three large nuclear plant configurations. Nuclear plants in the 700 MW(e) net power range are shown to compare favorably on the basis of unit steam and power costs and in total power plant operating costs. (H.D.R.)

16233 SENSITIVITY ANALYSIS OF REACTOR POWER KINETICS. Kim, Ho Keun. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 147p.

Thesis.

Parameter variations in nuclear power reactors are analyzed by use of the concepts of sensitivity analysis. These concepts are applied to linear and nonlinear system models. In the linear system approximation, the root sensitivity is derived for a power reactor transfer function. The nonlinear reactor power kinetics can be represented by sequential equations. The characteristic Boolean matrix is developed by using the Kronecker delta algebra and automata theory. The manipulation of the characteristic Boolean matrix is appropriately described by semicycle representation. The sensitivity equations are solved with the reactor sensitivity matrix and the Boolean matrix solutions. This technique may be applied further to the analysis and synthesis problems of any system containing nonlinear elements which can not be solved by conventional differential equation methods. (Disser. Abstr.) (TSS).

16234 STEAM GENERATING NUCLEAR REACTOR SYSTEMS. Johnson, Frank Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,100,626. Jan. 24, 1968. Filed Feb. 27, 1964.

A pressurized-water reactor is described. The reactor consists of a core containment vessel enclosed in a water filled secondary containment vessel. The core containment vessel is vented into the water of the secondary containment vessel. The secondary containment vessel is vented by non-return relief means into an external water supply. Electrical generating equipment is located in the secondary containment structure. (D.C.C.)

16235 NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,095,526. Dec. 20, 1967. Priority date Apr. 29, 1964, Germany.

The description of a gas-cooled nuclear reactor with a high-pressure vessel is presented. The reactor has an inner thermal shield that forms a vessel inside the high-pressure vessel. Cooling gas is circulated by blowers, and the space between the vessels is connected to the intake chamber of a circulating blower. The intake chamber is arranged between the circulating blower and the heat exchanger. (D.C.C.)

16236 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Brown, Gordon (to United Kingdom Atomic Energy Authority). British Patent 1,100,721. Jan. 24, 1968. Filed May 26, 1964.

The description of a pressurized-gas-cooled nuclear reactor with on-load refuelling devices is presented. The reactor core consists of multiple fuel channels inside a pressure vessel with penetrating refuelling pipes. The refuelling pipes are arranged in groups inclined so that the imaginary longitudinal axial extensions of the channels mutually converge to a minimum lateral spacing in the region of the penetration of the pressure vessel. (D.C.C.)

16237 METHOD AND ARRANGEMENT FOR LOADING AND UNLOADING FUEL ELEMENTS IN NUCLEAR REACTORS. Mueller, Arno (to Gesellschaft fuer Kernforschung, mbH). British Patent 1,097,918. Jan. 3, 1968. Filed Nov. 25, 1965.

The description of a loading and unloading machine for a liquid Na-cooled reactor is presented. The Na level in the reactor vessel is lowered to a position as close as possible above the fuel element head after normal operation. A difference in the gas pressure above the liquid coolant in the vessel and in the loading tube is used to support a column of liquid Na to the upper limit of the fuel element in the loading tube. The loading tube has an open bottom and is immersed in the liquid coolant. Before an element is loaded or unloaded the coolant level is lowered below the fuel element heads for proper coupling. The loading tube is equipped with a coolant channel. (D.C.C.)

16238 NUCLEAR REACTOR INSTALLATIONS. Sinclair, William Norman (to United Kingdom Atomic Energy Authority). British Patent 1,101,263. Jan. 31, 1968. Filed Oct. 16, 1964.

A refueling facility for a reactor of the Steam Generating Heavy Water Moderated Reactor type is described. A shielded refueling machine with a retractable nose unit for engaging the end of a fuel channel is situated on the top rotating biological shield cover. The nose unit is detachable from the refueling machine and is supported by the rotating shield cover. By rotating the shield cover, the nose unit can be selectively located over any of the fuel element channels. (H.D.R.)

16239 NUCLEAR REACTOR. Malherbe, Jean; Pelce, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,095,967. Dec. 20, 1967. Priority date Oct. 6, 1965, France.

The description of a multiple fuel element gas-cooled reactor is presented. The fuel elements are tubular with constant cross section, and each element is formed by multiple cartridges. The outer fuel element jacket serves as a moderator material and forms a coolant passage with the cartridges. The last cartridge in each fuel element has a smaller jacket than the others to allow for a duct. The cartridges are unloaded through the bottom of the fuel element. (D.C.C.)

16240 NUCLEAR REACTOR. Martin, Terence Cecil Gilbert; Webb, John (to United Kingdom Atomic Energy Authority). British Patent 1,096,026. Dec. 20, 1967. Filed Nov. 11, 1963.

The description of a liquid-cooled reactor is presented. The core of the reactor consists of multiple hexagonal fuel tubes welded in a honeycomb configuration. Coolant is circulated through the bottom open ends of the fuel tubes and exits through apertures provided on the length of the tubes. The upper ends of the fuel tubes are plugged. The coolant streams are controlled by supported baffles. (D.C.C.)

16241 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Ackroyd, Ronald Tunstall; Perks, Maurice Arthur; Mann, John Erskine; Barker, Allan (to United Kingdom Atomic Energy Authority). British Patent 1,101,539. Jan. 31, 1968. Filed June 19, 1964.

A fast reactor cooled by supercritically pressurized steam with means to counteract reactivity gain on flooding is described. The core is separated into three parts with flow guides to direct the coolant through the core in separate passes from outer to central parts. An epithermal neutron absorber is dispersed in the fuel in the central part of the core to counteract the contribution of ^{239}Pu to the reactivity rise on flooding. (H.D.R.)

16242 NUCLEAR REACTOR INSTALLATIONS. O'Dell, Frederick Peter; Green, Albert (to United Kingdom Atomic Energy Authority). British Patent 1,100,502. Jan. 24, 1968. Filed Aug. 31, 1964.

A description of a liquid moderated reactor formed by multiple pairs of rectilinear pressure vessels is presented. Each pair of pressure vessels has pressure tubes extending through the fuel lattice with pressurized liquid coolant. The pressure tubes are arranged in pairs of rows extending perpendicular to the adjoining pressure vessel sides, and they are connected by side branch pipes extending perpendicular to the rows of pressure tubes. The pressure vessels are connected in side-by-side arrangement with the side branch pipes leading to a heat exchanger. (D.C.C.)

16243 NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,102,174. Feb. 7, 1968. Priority date Aug. 19, 1964, Germany.

The description of a steam-cooled reactor is presented. The coolant loop consists of superheated steam fed from the top of the core into a pressure vessel beneath the core; circulating blowers for the circulation of cooling steam attached outside the pressure vessel; and a steam distribution header between the core and the steam generator which feeds saturated steam into the core for cooling. (D.C.C.)

16244 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 1,097,745. Jan. 3, 1968. Priority date June 15, 1964, United States.

A description of a gas-cooled fast reactor is presented. The reactor core consists of a plurality of fuel element assemblies supported by a grid located in a pressure vessel. Each assembly has vertically extending elongated fuel elements. The fuel assemblies are supported by an open end box surrounding the assemblies and fastened at the lower end. The upper end of the box is unrestrained. In case of a loss of gas coolant a water flooding device is provided. The reactor has an aligned pressed concrete pressure vessel and a thermal shield between the pressure vessel and circulator and steam generator. (D.C.C.)

16245 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,102,606. Feb. 7, 1968. Priority date Aug. 28, 1964, Luxembourg.

A description of a liquid-cooled nuclear reactor is presented. The reactor consists of a pressure vessel; a primary liquid coolant circuit; a heat exchanger; and coolant circulation pumps. The heat exchanger is subdivided so that the first region is upstream, and the second region is downstream from the pump rotors. A pressurizer is situated upstream from the pumps. Hydraulically controlled neutron absorber rods one located above the core and connect to the lower end of the second region and lower end of the first region. (D.C.C.)

16246 SPECTRAL SHIFT REACTOR CONTROL. (to United States Atomic Energy Commission). British Patent 1,102,050. Feb. 7, 1968. Priority date Jan. 21, 1966, United States.

A description of a spectral shift control for a liquid sodium-cooled fast neutron reactor is presented. The control system consists of a pump for circulating Li containing Na through the reactor. By adding and withdrawing selected amounts of Li from the liquid Na, the reactivity is changed as desired. Separate Li-rich and Na-rich phases of the Li–Na mixture are maintained by temperature regulation. (D.C.C.)

Marine and Portable Power Reactors

16247 (CONF-671011–, pp 107-126) NONDESTRUCTIVE FLAW DETECTION IN NUCLEAR POWER INSTALLATIONS. Parry, D. L. (Phillips Petroleum Co., Idaho Falls, Idaho).

Investigations and feasibility studies involving the application of the acoustic analysis phenomena for flaw detection, flaw definition, and incipient failure prediction have led to the utilization of an operable in-plant analysis system. This system has shown capability for detecting and locating flaws in the complex reactor pressure vessel and primary loop piping of operative nuclear power installations. Due to fluid flow noise interference, it is limited at this time to application in the hydrostatic test mode. Even in its present stage, acoustic analysis provides a valuable tool for inspection of pressure vessels and pressure piping. (auth)

16248 (EUR-3745) KERNENERGIE-FORSCHUNGSSCHIFF "OTTO HAHN". JAHRESBERICHT 1966. (Nuclear Research Ship "Otto Hahn." Annual Report, 1966). (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). Jan. 1968. Contract 009-64-7 PNID. 106p. (In German). Dep.

The present report contains a summary of the main work done and progress made in 1966 in the construction and further planning of the nuclear energy research ship "Otto Hahn." The breakdown of the contents includes: progress in conventional ship and turbine construction; and work on the ship's reactor. The 1966 Annual Report contains for the first time a section on the commissioning of the ship. The extensive work on the secondary plant, which made

considerable progress in 1966, and on the electrical plant and the instrumentation, is also dealt with in separate chapters. (auth)

16249 TWO PHASE FLOW BEHAVIOR INDUCED BY SHIP'S MOTION. Kurosawa, Akira; Fuji-i-e, Yoichi (Japan Nuclear Ship Development Agency, Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 584-6(Nov. 1967).

The effects of ship motion on a marine reactor's fluid flow system behavior were investigated for both natural circulation and forced flow systems. Results are presented for the inlet flow acceleration caused by ship motion or a step heat flux change using a model assuming one-dimensional time-dependent two phase flow. (H.D.R.)

Rocket and Space Reactors

16250 (NAA-SR-12605) S8DR ACTUATOR INTERIM REPORT. Long, W. G. (Atomics International, Canoga Park, Calif.). Dec. 30, 1967. Contract AT(04-3)-701. 35p. Dep. CFSTI.

The design of the SNAP-8 Prototype System rotary actuators is given. Control drum requirements are listed. Results of performance testing are tabulated; the performance is evaluated. Actuator environmental design criteria are given. Problem areas are outlined. (M.L.S.)

16251 COMPARISON OF BERYLLIUM PHOTONEUTRON DECAY SETS USING EXPERIMENTAL SNAP DATA. Ottewitte, Eric H. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Nucl. Sci. Eng., 31: 343-6(Feb. 1968).

The photoneutron decay sets of Rotter and Keepin are compared using SNAP experimental data. Effects of precursor buildup are shown; application of the two sets to SNAP reactor data is evaluated. (M.L.S.)

16252 NUCLEAR, THERMAL, AND ELECTRIC ROCKET PROPULSION: FUNDAMENTALS, SYSTEMS, AND APPLICATIONS. AGARD/NATO First and Second Lecture Series in Cooperation with the Universite Libre de Bruxelles, 12-21 November 1962; 28 September-2 October 1964. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967. 648p. (NP-17248; AGARDograph-101).

Classroom lectures, presentations, and discussions on the problems, prospects, and possibilities in the nuclear propulsion field are summarized. Separate abstracts were prepared for each of the 10 papers included. (H.D.R.)

For abstracts of individual papers see: 14733, 14734, 16253-16259, and 16377.

16253 EUROPEAN VIEW OF NUCLEAR PROPULSION. Jaumotte, A. L. (Univ. Libre, Brussels). pp ix-xii of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

The European problems in research on nuclear rocket propulsion are outlined. Possibilities for future space missions which would require nuclear propulsion are examined. (H.D.R.)

16254 ROLE OF NUCLEAR ENERGY IN SPACE FLIGHT. Bussard, R. W. (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). pp 1-18 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

A review of the long-term requirements for practical manned space flight shows that the rocket vehicle systems needed must be capable of providing incremental velocity changes of 100,000 ft/sec to 250,000 ft/sec. These values are from two to five times greater than the capabilities of chemical rocket propulsion systems now contemplated or thought possible. They can be achieved effectively only by the use of nuclear energy, either directly in nuclear/thermal rockets or indirectly in nuclear/electric rockets. Thus, the future of practical manned space flight rests on the successful development of a variety of nuclear-powered space propulsion systems. A survey of the technical possibilities indicates that nuclear/thermal rockets of both high and low thrust can improve capabilities in the next two decades, that nuclear/electric systems offer promise for the last two decades of this century, and that fusion propulsion may provide the eventual system for manned flight early in the twenty-first century, and later allow the first attempts at interstellar probes and travel. (auth)

16255 FUNDAMENTALS OF NUCLEAR PROPULSION. Bussard, R. W. (TRW Space Technology Labs., Inc., Redondo Beach, Calif.). pp 21-83 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

The analysis of space vehicle performance is examined from the equations which describe the external ballistics and the internal dynamics. The fundamentals of propulsion by nuclear reactors are discussed starting with the basic reactor neutronics, shielding, heat transfer mechanisms, and materials requirements. Reactor design principles and engine cycle selection for specific missions are presented. (H.D.R.)

16256 FAST AND MODERATED REACTORS AND APPLICATIONS OF LOW-POWER NUCLEAR ROCKETS. Rom, Frank E. (Lewis Research Center, Cleveland). pp 155-241 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

There are two basic types of reactors that can be considered for any application including the nuclear rocket. They are the thermal reactor and the fast reactor. The thermal reactor can be homogeneous or heterogeneous depending on whether the fissionable fuel is distributed within or separated from the moderator. The fast reactor is essentially a homogeneous reactor. Inasmuch as it is necessary to produce the highest possible propellant temperature to achieve the highest specific impulse, the materials which must be used for nuclear rocket reactors are the most refractory metals or ceramics. A discussion of the most refractory materials includes suitability for use in fast or thermal reactors by considering such characteristics as melting point, tensile strength, creep strength, thermal conductivity, expansion coefficient, modulus of elasticity, reaction with hydrogen propellant, evaporation rates, compatability with fuel compounds, nuclear cross-section, and availability. The potential of these materials for nuclear rocket use as limited by the above properties is discussed. Several reactor concepts utilizing the materials discussed above are presented to indicate possible configurations to be investigated further. The compromises which may be necessary to achieve feasible propulsion systems based on each reactor concept are outlined. Performance estimates are made of the various concepts so that comparisons can be made on the basis of size, weight, fuel loading requirements, etc. These considerations are summarized by pointing out the problem areas of the various concepts and the kind of work which must be done to solve them. Potential applications of small fast and thermal nuclear rockets are examined. Missions which may be of interest to the scientific community such as solar, planetary, and deep-space probes are discussed to point out velocity increment requirements. The power and operating time requirements for nuclear rockets which would be used to accomplish these missions are computed. The capability of the various concepts to accomplish these missions is determined to indicate the potential of fast and moderated nuclear rockets. (auth)

16257 NUCLEAR ROCKETS BASED ON GRAPHITE REACTOR TECHNOLOGY: THEIR APPLICATIONS AND DEVELOPMENT STATUS. Finger, Harold B.; Johnson, Paul G.; Morrissey, John E.; Siegel, Alan R. (Atomic Energy Commission, Washington, D. C. National Aeronautics and Space Administration, Washington, D. C.). pp 242-337 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

Described are the present NERVA, Nuclear Rocket Engine for Vehicle Application, configuration and the major technical considerations that determined the configuration of the engine. In addition, the technical considerations that determine and limit the operating characteristics and performance of the overall engine system including consideration of steady state performance and transient engine operation are discussed. The status of reactor and non-nuclear component and overall system development and operation is also described. Although the major emphasis in the discussion is on the NERVA engine configuration as it has been established during the past several years, consideration is also given to configurations of higher power engines than the currently envisioned NERVA engine. Work that is underway aimed at development of higher power reactor systems is described. The potential use of clustered engine configurations in actual space mission applications of nuclear rockets is also discussed. The overall objective is to give an understanding of the design and operating characteristics of nuclear rocket engines required for difficult space missions involving extended stay-times on the

Moon, lunar bases, large instrumented missions throughout the solar system, and manned exploration of the near planets. (auth)

16258 OPERATIONAL SAFETY OF NUCLEAR ROCKETS. Dix, George P. (United States Atomic Energy Commission, Germantown, Md. National Aeronautics and Space Administration, Germantown, Md.). pp 338-57 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

The safety philosophy, analytical model, conceptual operations and countermeasures, operational safety analysis program, and safety engineering program for nuclear rockets are described. (H.D.R.)

16259 NUCLEAR SPACE POWER SYSTEMS: REACTORS, CONVERSION EQUIPMENT, AND POWER SYSTEMS TECHNOLOGY. Dieckamp, H. M. (Atomics International, Canoga Park, Calif.). pp 361-504 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Applications. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

The comparatively large energy associated with each nuclear fission event results in an effective reactor heat source energy density that provides significant advantages for space application. In addition to minimum reactor weight, usefulness in space requires high heat source temperature for minimum total power system weight. A survey of reactor criticality identifies the preferable concepts, configurations, and materials. Beyond criticality, reactor size and weight are determined by heat transfer and fuel material radiation damage limitations. The allowable operating temperature range is determined by the physical properties of the reactor materials. The composite of these considerations identifies the reactor concepts that are appropriate for space power and indicates the temperature and power regions of applicability. The radiative heat rejection requirement of a space power system places a premium on high temperature power conversion devices. A survey of the physical principles of thermoelectric, Rankine cycle, Brayton cycle, and thermionic power conversion defines the performance capabilities and limitations of each concept. Available materials, working fluids, and physical phenomena determine the useful tempera-range of the applicable approaches. The final selection of a power conversion device for a specific system is influenced by the power level, reliability requirements, and other system constraints. The extreme temperature dependence of the radiator area and weight, which is dominant in a high power system, dictates the concept progression required for increased performance (i.e., pounds/kilowatt). At the same time, the technology which determines power system availability is paced by temperature. The integration of a reactor heat source and power conversion device into a complete space power system requires detailed consideration of the space environment, the spacecraft, its launch sequence, and the mission. The most significant reactor space power system experience to date is contained in the U.S. AEC's SNAP (system for nuclear auxiliary power) Program which was initiated in 1956 and encompasses epithermal and fast reactors with direct and dynamic conversion in the power range from 500 watts to megawatts. A review of the development status of these programs defines the current and projected "state-of-the-art." Safety considerations need not impede the use of nuclear power in space. SNAP units will fill a range of applications and provide a vital capability for the future exploration and utilization of space. (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 16232 and 16361.

16260 (ORNL-TM-2006) ORVAC-TF: A FORTRAN CODE FOR THE CALCULATION OF A DESALINATION PLANT INCORPORATING A VAPOR COMPRESSOR SYSTEM TOPPING AN MSF PLANT. Friedrich, R. O. (Oak Ridge National Lab., Tenn.). Jan. 1968. 189p. Dep. CFSTI.

A program has been written for the IBM-7090 system which defines the operating characteristics and component costs of a vapor compressor-MSF coupled desalination plant complex. The plant complex consists of a reactor plant for the production of steam and a distillation plant for production of water. The distillation plant consists of a vapor compressor plant (two vertical evaporator effects, compressor, back-pressure turbine and generator) and an MSF plant which is used to preheat the vapor compressor feed stream and utilize the steam from the back-pressure turbine for further water production. The output from the program consists of all pertinent operating and cost information for the two major coupled plants. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 14893, 15141, 15171, and 15925.

16261 (AECL-2943) CURRENT STATUS OF CANADIAN ORGANIC COOLED REACTOR TECHNOLOGY. Mooradian, A. J.; Robertson, R. F. S.; Hatcher, S. R.; Hart, R. G.; Tegart, D. R.; Summach, A. J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sept. 1967. 20p. (CONF-670917-11). Dep. CFSTI. CAN $1.00.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

Developments in the operation of the Canadian organic cooled D_2O moderated pressure tube reactor WR-1 are presented. The operation of the WR-1 (Whiteshell Reactor) and supporting development programs are discussed. Coolant technology is detailed; pressure tube and fuel materials are analyzed. (30 references.) (M.L.S.)

16262 (AEEW-R-301) TRANSFER FUNCTIONS FOR A SUBCRITICAL REACTOR. Cummins, J. D. (Atomic Energy Establishment, Winfrith (England)). Aug. 1963. 10p. Dep. CFSTI. UK.

A programme is described for the Ferranti Mercury computer with which the transfer functions between either neutron source or reactivity and neutron flux in a subcritical reactor in pole-zero form may be calculated. The programme also computes the frequency responses corresponding to these transfer functions. An example of the use of the programme is presented. (auth)

16263 (AEG-E-31-873) HEISSDAMPFREAKTOR KAHL FORSCHUNGS- UND ENTWICKLUNGS-PROGRAMM. 10. VIERTELJAHRESBERICHT APRIL-JUNI 1967. (AEG Superheat Reactor R and D Program. Quarterly Report No. 10, April-June 1967). (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Dec. 15, 1967. 45p. (In German). Dep.

Irradiation testing of boiling water superheater fuel elements in the VAK reactor is discussed. Results of postirradiation examination of fuel elements which were in VAK during two large temperature excursions are given. Development of duplex tubes for end plugs of advanced Zr fuel elements is discussed. Results of the testing of seals between the superheater element and the superheated steam collector are discussed briefly. Details of postirradiation examination of small-type reactor superheater fuel elements are included. (M.L.S.)

16264 (AERE-M-1870) DETERMINATION OF NEUTRON FLUX PARAMETERS FROM REACTION RATE DATA FOR THERMAL AND EPITHERMAL FLUX DETECTORS USED IN HARWELL REACTORS. Jones, E. D.; Carter, P. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1967. 34p. Dep. CFSTI. UK.

The Westcott formulas used for determination of thermal and epithermal fluxes are discussed. The required flux detectors are described. Limitations of experimental methods are discussed. An example of neutron flux measurement and data reduction at Harwell is given. Harwell data are presented in tabular form. (13 references.) (M.L.S.)

16265 (ANL-7403) REACTOR DEVELOPMENT PROGRAM. Progress Report, December 1967. (Argonne National Lab., Ill.). Jan. 31, 1968. Contract W-31-109-eng-38. 168p. Dep. CFSTI.

REACTOR FUEL ELEMENTS — metal alloys for, postirradiation density measurements on; fabrication of U-Pu-Zr stainless steel jacketed; inspection of EBR-2, postirradiation; trace-element impurities in EBR-2, effects on swelling of; swelling of EBR-2, effects of temperature and pressure on; description of EBR-2 Mark-IIB oscillatory

REACTORS, LIQUID METAL-COOLED — fuels for, development of

REACTORS, FAST — fuels for, development of; neutron fluxes and currents in, ultrafine multigroup methods for calculating real and adjoint; safety experiments in TREAT, advanced heat-transfer analysis model for

REACTORS, BREEDER — fuels for, development of

URANIUM ALLOYS — Pu-U-Zr, radiation effects on

PLUTONIUM ALLOYS — Pu–U–Zr, radiation effects on
ZIRCONIUM ALLOYS — Pu–U–Zr, radiation effects on
VANADIUM ALLOYS — mechanical properties of, radiation effects on
CRITICAL ASSEMBLIES — neutron fluxes and currents in ZPR-3, ultrafine multigroup methods for calculating real and adjoint
SODIUM — purity of, use of steam-reaction method for determining; effects on materials wear properties; analyses for iodine-131 and cesium-137 in EBR-2 coolant, radiochemical; transient behavior under accident conditions, TREAT experiments on
TRANSDUCERS — development of fission gas pressure
FLOWMETERS — magnetic materials for, thermal and mechanical testing of
CABLES — sodium effects on electrical connector
EXPERIMENTAL BREEDER REACTOR-II — fission product release in, fission gas monitor response to; cover gas for, activity measurement of argon; Fuel Element Rupture Detection system for, failure of fission product release indication by; control rod No. 5 for, 5 inhour discrepancy in reactivity worth of; transfer function measurements for Run 26 in; feed back data as function of power level in; power coefficient for, effects of linear and nonlinear feedback on; sodium coolant for, carbon determination in; sodium coolant for, determination of tritium in; experiment irradiations in, status of; materials for, effects of sodium and radiation on; maintenance for; Fuel Cycle Facility for, operations history of
REACTOR CONTROL ELEMENTS — reactivity variation in EBR-2 No. 5
REACTIVITY — variations in EBR-2, determination of fuel-temperature feedback by measuring
SUPERHEATERS — vibration testing of EBR-2
YTTRIUM — neutron cross section measurements for
URANIUM ISOTOPES U-238 — fission fragments of, angular distribution of
URANIUM OXIDES — PuO_2–UO_2–FP, separation from irradiated fuels, fluorination process for
PLUTONIUM OXIDES — PuO_2–UO_2–FP, separation from irradiated fuels, fluorination process for
FISSION PRODUCTS — PuO_2–UO_2–FP, separation from irradiated fuels, fluorination process for
ARGONNE ADVANCED RESEARCH REACTOR — coolant loss accidents analysis for; transient stress analyses for; neutron windows for, cooling requirements for; reflector for, tensile properties of; fuel zone for, fractional distributions of fission events in
REACTOR SAFETY EXPERIMENTS — transient sodium behavior under accident conditions in TREAT; operations summary for TREAT
HEAT TRANSFER — analysis of TREAT fast reactor safety experiments, advanced model for
ALKALI METALS — surface tension measurements for
REACTORS — core for, plastic deformation, determinations for
REACTORS, BOILING — design parameters for 3300 MW(t), conceptual
REACTOR CONTAINMENT SYSTEMS — hydrodynamic response to high-energy excursion (M.L.S.)

16266 (BNL–12169) EVALUATION OF FISSION PRODUCT AND ACTIVATION ISOTOPES IN A REACTOR STACK EFFLUENT AND IN THE NEARBY ENVIRONMENT. Hull, A. P.; Gilmartin, J. T.; Smith, M. E. (Brookhaven National Lab., Upton, N. Y.). [1966]. 18p. Dep. CFSTI.

A one-year study of the gamma emitting isotopes present in concentrations greater than 1.0 pCi/m^3 in the Brookhaven Graphite Research Reactor (BGRR) stack effluent has been made. For the first three months a May-pak sampler was employed, and a conventional particulate and charcoal filter employed for the balance of the year. The only relatively short-lived isotopes detected were ^{82}Br in a concentration of 4.2×10^3 pCi/m^3 and ^{133}I in a concentration of 2.2×10^3 pCi/m^3. The May-pak indicated that most of the BGRR effluent radioiodine was in states other than methyl iodide. The intermediate and longer lived isotopes detected included both activation and fission products. Among the activation products, ^{203}Hg was present in the greatest concentration (21 pCi/m^3) and among the fission products, ^{131}I(4×10^2 pCi/m^3). Ground level air concentrations of ^{82}Br and ^{133}I in the order of 5×10^{-14} $\mu Ci/cm^3$ were found in three separate one-day samples. The amounts were somewhat less than those calculated from meteorological dispersion considerations. Two precipitation samples have been obtained at times when the BGRR plume was over a collector. Although ^{82}Br and ^{131}I were detected, the definition of the precipitation was found to be inadequate to permit the verification of washout factors. (auth)

16267 (BNWL–500) FAST FLUX TEST FACILITY OVERALL CONCEPTUAL SYSTEMS DESIGN DESCRIPTION. Steele, C. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 7, 1967. Contract AT(45-1)-1830. 75p. Dep. CFSTI.

The description of the first overall systems design for the FFTF is given. General discussions are given on: utility systems, reactor systems, irradiation test systems and facilities, component handling systems, examination systems and facilities, and unified instrument and control systems. Design requirements for the FFTF are delineated. The safety philosophy behind the systems designs is outlined. Detailed descriptions of the systems are given. (M.L.S.)

16268 (BNWL–607) FAST FLUX TEST FACILITY CRITERIA FOR CONTAINMENT. Wittenbrock, N. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 27p. Dep. CFSTI.

The sources of radionuclides in the FFTF are considered; considerations for containment criteria are discussed for each facility. Operation of the containment systems is described. Design safety criteria for containment are delineated. An estimate of fission product decay heat is made from PRTR data. Possibility of FFTF fuel storage basin criticality accidents is evaluated. (M.L.S.)

16269 (BNWL–618) REACTIVITY WORTH OF A CENTRAL SAFETY ROD WITH AND WITHOUT AN INTERNAL SCATTERER. Uotinen, V. O.; Pitner, A. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

An experiment has been performed in the D_2O-moderated Plutonium Recycle Critical Facility (PRCF) to determine the increase in the negative reactivity worth of a hollow Cd safety rod when a scattering material (Lucite) is placed inside the safety rod. The experiment was conducted to investigate the feasibility of increasing the worth of the PRCF safety system for special purposes, and to evaluate calculational methods of determining the worth of safety rods with internal scattering. The PRCF was loaded with a two-zone configuration of 1.8 wt % Pu–Al and natural UO_2, and the safety rod was located in a central fuel channel. Results of worth measurements are presented. (auth)

16270 (BNWL–633) THE EXPERIMENTAL DETERMINATION OF FAST FISSION EFFECT IN GRAPHITE MODERATED, WATER COOLED, SLIGHTLY ENRICHED URANIUM LATTICES. Newman, D. F.; Pervich, M. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 30, 1967. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

Measurements of fast fission effect in several graphite moderated water-cooled slightly enriched U lattices in the Physical Constants Test Reactor are discussed; results are given. Depleted and enriched U foils were used to measure activities; these activities are tabulated. 9 references. (M.L.S.)

16271 (BNWL–666) FAST FLUX TEST FACILITY DEVELOPMENT MONTHLY PROGRESS REPORT, DECEMBER 1967. Woodfield, F. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 10, 1968. Contract AT(45-1)-1830. 47p. Dep. CFSTI.

Remote weld techniques are being evaluated as an approach for the closed loop nozzle closures and piping disconnects. Mechanical seals will continue to be investigated. A new concept which provides for latching the driver closure internally in the nozzle will possibly make a significant reduction in reactor top face hardware space requirements. No significant dose rate effects on chromel-alumel thermocouples, other than gamma heating, were observed in plused-reactor experiments. Tests were run at a temperature of 446°F and in fluxes up to 10^{16} nv fast (>10 keV), 10^{16} nv thermal (<10 keV), and 10^{10} R/hr. Studies of the closed loop insulation requirements, methods, and materials have continued. A twin wall tube with argon in the gas gap and polished radiating surfaces appears to be one of the better thermal barrier systems. The out-of-reactor serpentine dehydration tests have been completed. Heating of serpentine for 2500 hours at 940°F resulted in a 10.8% weight loss. The original water content was 13.0%. Heating at 896 and 860°F for 2500 hours results in losses of 8.4 and 3.9% respectively. (auth)

16272 (CEA–R–3326) INTRODUCTION A L'ETUDE DE L'EBULLITION DANS LES REACTEURS PISCINES. ESSAI DE MESURE DE L'EFFICACITE D'UNE CHAMBRE C C 5. (Introduction to the Study of Boiling in Swimming-Pool Reactors. Measurement of the Efficiency of a C C 5 Chamber). Froelicher, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 11p. (In French). Dep.

The efficiency of a CC5 ionization chamber has been evaluated by a rough measurement: by integrating the relationship $P(f) = \epsilon Fo(1 + \epsilon A)$ over the band width of the apparatus, it is possible to show the influence of ϵ. This conventional method of operation is not very precise and so a more realistic value of the efficiency will be derived later using the plot of the low power transfer function of the reactor ULYSSE. (auth)

16273 (CONF-671011–, pp 16-27) ON-LINE TESTING OF SAFETY INSTRUMENTATION FOR THE HFIR. Anderson, J. L. (Oak Ridge National Lab., Tenn.).

The HFIR protection system utilizes signals from three separate, but equivalent, channels in a two-out-of three coincidence arrangement. This means that two of the three channels must agree that safety action is required before the reactor can scram. The input derived from the various channels for monitoring reactor operating variables is examined, and routine on-line tests of the coincidence elements are described. In addition, some nonroutine testing, trouble isolation, and calibration checks are mentioned briefly. (H.D.R.)

16274 (CONF-671011–, pp 61-8) REACTIVITY ANOMALY DETECTION IN THE HFIR WITH AN ON-LINE COMPUTER. Bullock, J. B. (Oak Ridge National Lab., Tenn.).

In the High Flux Isotope Reactor, large and rapidly changing ^{135}Xe poisoning effects complicate the ability of the reactor operator to evaluate the validity of a reactivity request from the servo system. To aid the operator in detecting and preventing reactivity anomalies, an on-line Control Data-1700 digital computer is used to calculate the expected reactivity balance of all times from measured heat power and temperature information. An appropriate reactivity model is used to continuously calculate reactivity changes associated with fuel burnup, burnable poison depletion, fission products, and temperature changes. (H.D.R.)

16275 (CONF-671011–, pp 89-101) NEUTRON DENSITY FLUCTUATIONS AS A REACTOR DIAGNOSTIC TOOL. Fry, D. N.; Robinson, J. C. (Oak Ridge National Lab., Tenn.).

Neutron density fluctuation analyses performed at the High Flux Isotope Reactor and the Molten Salt Reactor Experiment are described. The objectives of the noise analysis program are to develop an on-line reactor diagnosis tool that will detect anomalous reactivity effects and not disturb the operation of the reactor and to develop neutron fluctuation analysis as an aid in identifying the origin of reactivity fluctuations. The procedures used and spectra obtained in neutron density fluctuation measurements in HFIR and MSRE are presented. (H.D.R.)

16276 (CONF-671011–, pp 370-6) TEST REACTOR INCIDENTS: SELECTED CASE HISTORIES. DeBoisblanc, D. R. (Idaho Nuclear Corp., Idaho Falls).

Three incidents which occurred during operations of the Engineering Test Reactor are described and their methods of analysis are discussed. Two of the incidents involved fuel plate meltdown because of coolant flow interruption by foreign material in the reactor. The third event was a power fluctuation caused by vibration of the inner flow tube of a pressurized water loop. (H.D.R.)

16277 (EUR-3667) OPERATIONS GROUP OF THE BR-2 REACTOR AND CONNECTED INSTALLATIONS. Annual Progress Report, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Oct. 26, 1967. 64p. Dep.

Operation of the BR-2 and its associated installations was carried out under the Contract of Association signed between Euratom and the CEN. By the terms of this Contract, concluded in 1960 for a period of twenty years, the parties concerned use the installations, which are operated jointly for their own purposes; they may also make them available to any other parties they please for the latter's requirements. Implementation of the Contract is directed by a Management Committee, which met six times in 1966 to draw up the programmes and ensure the technical coordination of the various uses to which the installations are put. Since 1963 the operation of the reactor has proved the real advantages which it derives from its unique characteristics and in particular its ability to satisfy the new requirements of experimental workers. In 1966 the help given by BR-2 to the large-scale nuclear projects of the European Community was again stepped up, while at the same time irradiation programmes were also carried out for non-Community countries such as Great Britain and Japan. (auth)

16278 (EUR-3735) OPTIMIZATION OF CONTROL SYSTEMS BY AN ANALOG METHOD. Garroni, A.; Lucia, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 7, 1967. 26p. Dep.

A method of optimizing the operation of a plant subject to random disturbances, whose effect can be decreased by means of suitable non-linearities inserted in the feedback chain, is described. The system in question, which is subjected to random stationary perturbations, is optimized under operating conditions, in the steady state, by minimizing a functional consisting of a linear combination of mean quadratic values and mean moduli of a few significant parameters. By using analog techniques to solve the dynamic equations of the system, the perturbations are introduced as perturbing signals; the functional is obtained in terms of the parameters of the nonlinearities. A minimum condition can thus be readily pinpointed. Particular reference is made to nuclear reactors, in which hypotheses and techniques of this type play a particularly important part. Results for the ISPRA I reactor are given as an example. (14 references.) (auth)

16279 (GEAP-5100-2) HIGH PERFORMANCE UO_2 PROGRAM. MOLTEN FUEL ROD OPERATION TO HIGH BURNUP. Lyons, M. F.; Wilson, C. R.; Boyle, R. F.; Pashos, T. J.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Nov. 1966. Contract AT(04-3)-189. 94p. (EURAEC-1893). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A fuel assembly containing four Zircaloy-2 clad, UO_2 fuel rods was irradiated successfully in the GETR-PWL to high burnup while operating with gross central melting. This assembly, designated EX-12A, contained two compacted powder and two cored pellet fuel rods. Both types of rods had nominally 0.5-inch diameter fuel columns, were clad with Zircaloy-2 and were typical in design and configuration to those used in current power reactor cores. The irradiation performance data on the individual assembly fuel rods are presented. This report describes the fabrication data, operating conditions and post-irradiation examination results from the EX-12A assembly. (auth)

16280 (GEAP-5100-H) HIGH PERFORMANCE UO_2 PROGRAM. IRRADIATION OF 0.5 INCH DIAMETER, VIBRATORY COMPACTED POWDER UO_2 FUEL RODS TO 1.0×10^6 Btu/h-ft^2 PEAK HEAT FLUX: ASSEMBLY EPW 6/8V. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Apr. 1966. Contract AT(04-3)-189. 95p. (EURAEC-1680). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete correlated post-irradiation examination results are described for a four-rod fuel assembly—designated EPW-6/8VC—that was irradiated in the GETR-PWL. The fuel rods in this assembly were unsegmented, reactor length rods, clad in freestanding Zircaloy-2 and fabricated by vibratory compaction to an average bulk density of 87 percent. This fuel assembly was the third of a series irradiated to determine the feasibility and limitations in operating compacted powder UO_2 fuel rods with central melting. The successful irradiation of this assembly, with only very slight clad swelling, provided the basis for the irradiation of 83.85 percent dense powder fuel rods at significantly higher thermal performance levels. (auth)

16281 (GEAP-5100-K) HIGH PERFORMANCE UO_2 PROGRAM. FIRST PINHOLE FUEL ROD FAILURE DURING CENTRAL MELT OPERATION: ASSEMBLY EPT-12C-A. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, G. R.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Sept. 1966. Contract AT(04-3)-189. 59p. (EURAEC-1768). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete, correlated post-irradiation examination results are described for a four rod fuel assembly, designated EPT-12C-A, that was irradiated in the GETR-PWL at gross center melt conditions. The fuel rods in this assembly were unsegmented, reactor length rods, containing hollow, sintered UO_2 pellets clad with freestanding Zircaloy-2 cladding. Two of the fuel rods contained 95 percent basic density UO_2 and had been previously irradiated successfully to 5300 MWD/Te in Assembly EPT-12C. The other two rods in EPT-12C-A were newly fabricated using different lots of Zircaloy-2 tubing and UO_2 but the design was identical with the exception of the basic UO_2 density, which was 92 to 93 percent. A mild, pinhole-type failure was experienced in previously irradiated Rod 12BC during the startup of this assembly before reaching full power (29MW) and the irradiation was terminated. Intensive postirradiation examination of rod 12BC was performed using the most advanced analytical techniques available in an effort to determine the cause of failure. Some circumstantial evidence relating the pinhole to a fission product iodine-Zircaloy-2 interaction was obtained. However, the chronological and burnup simultaneity of this

failure with the rod swelling and failure in the preceding assembly, EPT-12C, and a second pinhole failure in the succeeding assembly, EPT-12C-B, makes an interrelationship between the three failures an almost inescapable conclusion. The excessive reactor power rise rate during the preceding EPT-12C assembly failure is considered the likely first cause of the failure but the mechanism by which this event induced the pinhole type of attack is unknown. (auth)

16282 (GEAP-5100-L) HIGH PERFORMANCE UO_2 PROGRAM. SECOND PINHOLE FUEL ROD FAILURE DURING CENTRAL MELT OPERATION; ASSEMBLY EPT-12C-B. Lyons, M. F.; Zimmerman, D. L.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). Sept. 1966. Contract AT(04-3)-189. 104p. (EURAEC-1769). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete, correlated post-irradiation examination results are described for a four rod fuel assembly, designated EPT-12C-B, that was irradiated in the GETR-PWL at gross center melt conditions. The fuel rods in this assembly were unsegmented, reactor length rods, containing hollow, sintered UO_2 pellets in freestanding, Zircaloy-2 cladding. One of the fuel rods contained 95 to 97 percent basic density UO_2 and had previously been irradiated successfully to 5300 MWD/Te in Assembly EPT-12C and for an additional 15 MWD/Te in Assembly EPT-12C-A. Two of the other three rods, Rods 12GC and 12HC, had been irradiated for a very short period during the EPT-12C-A assembly startup while the third rod, Rod 12 FC, was unirradiated. These latter three rods were all newly fabricated using different lots of Zircaloy-2 tubing and UO_2 from that used for Rod 12CC, but were otherwise identical in design with the exception of the basic UO_2 density which was 92 to 93 percent. This assembly was the third attempt to continue the irradiation of hollow pellet fuel rods, operating at gross central melting conditions, after completely successful operation to an average burnup of 5300 MWD/Te. After 12 hours of steady state, full power operation, a mild pinhole type failure was experienced in the one remaining, high burnup rod, Rod 12CC. Intensive post-irradiation examination was performed on Rod 12CC using the most advanced analytical techniques available in an effort to determine the cause of failure. Some circumstantial evidence relating the pinhole to a fission product iodine–Zircaloy-2 interaction was obtained. However, the chronological and burnup simultaneity of this failure with the rod swelling and failure in the original assembly, EPT-12C, and to the first pinhole failure in the preceding assembly, EPT-12C-A, makes an interrelationship between the three failures an almost inescapable conclusion. The excessive reactor power rise rate during the preceding EPT-12C assembly failure is considered the likely first cause of the failure but the mechanism by which this event induced the pinhole type of attack in unknown. (auth)

16283 (IAEA-3498-21) PROGRESS REPORT OF NORA PROJECT, OCTOBER 1–DECEMBER 31, 1967. (Institutt for Atomenergi, Kjeller (Norway)). Jan. 1968. 32p. (NC-95). Dep. CFSTI.

An operations history of the NORA reactor is given. Measurements of macroscopic neutron flux distribution are described; values for thermal, epithermal, and fast neutron buckling are given. Reactivity measurements made with grey control elements are described; results are tabulated. Spectrum index measurements and calculations are presented. (M.L.S.)

16284 (IN-1149) A PROPOSAL FOR A REPETITIVELY PULSED TEST FACILITY (RPTF). Fluharty, R. G.; Simpson, F. B.; Russell, G. J.; Morris, R. H. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 119p. Dep. CFSTI.

A preliminary reactor concept, consisting of a small plutonium booster reactor producing 3 to 10 MW of average power in conjunction with a charged particle neutron source, is proposed. Pulse frequencies variable from 0 to 200 pulses per second and widths variable between 10^{-7} and 10^{-5} seconds are obtainable with corresponding peak-power pulse-heights of 3,000 MW. In the neutron-spectrometer mode of operation, the reactor amplifies short neutron driving pulses from the charged particle source. High neutron gains and corresponding high reactor pulse power are obtained by means of rotating reactivity controls. The average reactivity of the reactor is maintained well below delayed critical, but short time operation between delayed and prompt critical permits large amplification of the source pulse. Schematic diagrams of the preliminary RPTF and system details and applications are included. (H.D.R.)

16285 (JAERI-1139) OUTLINE OF CRITICAL EXPERIMENT AND CHARACTERISTIC TEST OF JRR-4. (Japan Atomic Energy Research Inst., Tokyo). Apr. 1967. 26p. (In Japanese). Dep.

Japan Research Reactor-4 (JRR-4) is a swimming pool type reactor, 1,000 kW in thermal power with light water as the coolant and moderator. The fuel elements consist of planes of an alloy of 90% enriched ^{235}U and Al. The JRR-4 is installed as the fifth reactor in Japan Atomic Energy Research Institute, and intended mainly for the study of shielding. The JRR-4 is now in operation for the mock-up-tests of shielding of the first nuclear ship. Critical experiments and characteristic tests of JRR-4 are described. The tests include control rods calibration, thermal flux measurement, mass, void and temperature coefficient measurement, power up and full power test. (auth)

16286 (JAERI-1152) COMPUTER CONTROL OF THE STARTUP OF A NUCLEAR REACTOR. Fujisawa, Takeo; Koshii, Hideo; Watanabe, Koichi (Japan Atomic Energy Research Inst., Tokyo). 1968. 17p. (In Japanese and English). Dep.

In designing a computer control system, the determination of a sampling-rate is a fundamental problem, since the control system is essentially based on sampling principles and the system behavior is directly influenced by the sampling-rate. A description is given of the dependence of the critical loop gain and integral square error on the sampling-rate of the control system. The effect of reactivity change-rates is also described for realizing the optimum startup control of a reactor. An experiment was made on the computer control of the startup of the JRR-1 reactor for various set values of reactor periods, power levels and sampling-rates. Tests of reactivity insertion as disturbance were successfully conducted in the experiment to show the sufficient stability and applicability of the direct digital control system. (auth)

16287 (KFK-668) UNTERSUCHUNGEN AN DEN LADUNGEN 3 UND 4 DES SCHNELL-THERMISCHEN ARGONAUT-REAKTORS STARK. (Investigation on the 3rd and 4th Loadings of the Fast-Thermal Argonaut Reactor STARK). Barleon, L.; Brueckner, Chr.; Burkart, K.; Fieg, G.; Kuhn, D.; Kussmaul, G.; Meister, H.; Seufert, H.; Stegemann, D.; Werle, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sept. 1967. 93p. (In German). (EUR-3701). Dep.

A description of the fast-thermal reactor STARK is given. Critical experiments for the third and fourth core loadings are described; vertical and radial thermal flux traverses are shown; fission rate distributions are given for the fast zone; neutron spectral determinations are given for different positions in the fast zone of Core 4. Control rod reactivity worth measurements are given graphically; void and temperature coefficients of reactivity are determined for each core. Experimental techniques are described for all the experiments. 14 references. (M.L.S.)

16288 (NASA-TN-D-4270) ANALYSIS OF URANYL FLUORIDE SOLUTION REACTORS CONTAINING VOIDED TUBES. Mayo, Wendell (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1968. 24p. CFSTI.

Critical experiments with fully enriched (93.2% ^{235}U) uranyl fluoride–water solution reactors that contain arrays of large-diameter void tubes were analyzed satisfactorily. A calculational method that involves the direct application of widely used multigroup computer programs and techniques to cases of extreme heterogeneous voids is evaluated. Experimental critical solution heights for cores that contain no void tubes and for 19, 31, and 37 void tubes with a 7.658-cm diameter were obtained by using the NASA Zero Power Reactor-II facility. Both unreflected cores and cores radially reflected with 15.24 cm of water were considered. The void arrays with triangular lattice pitches of either 9.652 or 10.922 cm were centrally located in the 76.2-cm-diameter core tank. The critical heights of the voided reactors ranged from 21 to about 84 cm. The calculational method consists of first computing axial leakage rates from axially finite cylindrical cells that contain the void tube and a proportional amount of fuel solution. The cell dimensions and fuel are obtained from the corresponding critical reactors. Two-dimensional (r-z) S_4P_1 transport calculations with five energy groups of finite height cylindrical cells are used. The axial leakage rates per source neutron, obtained from the cell calculations, are incorporated into one-dimensional radially finite reactor calculations by defining an axial leakage cross section for each energy group to account for axial neutron streaming out of the voided region of the reactor. Disadvantage factors, which are also obtained from the two-dimensional cells, are important especially for the shorter height reactors that contain the more concentrated fuel solutions. The calculational method is satisfactory for the reactors examined and is readily adapted for use with other reactor configurations provided that two-dimensional (r-z) cells can be defined appropriately. (auth)

16289 (ORNL-TM-2082) CRITICAL EXPERIMENTS WITH ENRICHED URANIUM METAL–POLYETHYLENE, –PLEXIGLAS, AND –TEFLON MIXTURES. Magnuson, D. W. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 38p. Dep. CFSTI.

Reflected and unreflected critical experiments were performed at H:^{235}U atomic ratios from 0 to 5 in rectangular geometry with layers of enriched uranium and polyethylene. Base dimensions of the assemblies were 5 × 10 and 10 × 10 in. In some unreflected experiments, the metal was interleaved with Plexiglas and with Teflon at only the latter base dimensions. Heterogeneity effects were found to be small from experiments assembled from the same or approximately the same materials but with different layer thicknesses. Values of k_{eff} calculated with the KENO Monte Carlo code, are in excellent agreement with the experimental values. By equating geometrical bucklings for rectangular and spherical geometry, these data were converted to critical masses for spheres. Comparisons of the experimental values were made to the critical masses calculated by the ANISN transport code for homogeneous spheres. (auth)

16290 (ORNL-TM-2107) BULK SHIELDING FACILITY QUARTERLY REPORT, JULY, AUGUST, AND SEPTEMBER OF 1967. Tabor, W. H. (comp.) (Oak Ridge National Lab., Tenn.). Jan. 10, 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

The operations are tabulated and the mechanical and instrument maintenance is summarized for the Bulk Shielding Reactor and the Pool Critical Assembly. (H.D.R.)

16291 (PEL–154) THE HEALTH PHYSICS ASPECTS OF THE FAILURE OF A PLUTONIUM–BERYLLIUM START-UP SOURCE IN THE SAFARI 1 REACTOR. Craig, D. K.; Winkler, B. C.; Colley, J. R. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug. 1967. 32p. (CONF-660920-19). Dep.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

A neutron start-up source, containing 160 grams of Pu, was supplied by the subcontractors for the SAFARI I reactor. During the start-up and commissioning period, for which the reactor was under the control of the subcontractors, the container for this source ruptured. This allowed some of the Pu and its fission products to escape into the various reactor systems. The resulting increased levels of radioactivity were first indicated definitely on April 22 and, after extensive investigations, the rupture of the source container was discovered on April 26, 1965. After removing the source from the reactor vessel and taking such other steps as were practical to control the increased radiation and contamination hazards, the reactor was brought back to power on April 28 and was operated at full power for seven consecutive days. The events leading up to and surrounding the incident are described. The health physics aspects of the incident are presented and the consequences are discussed. It is shown that, while greatly increased radiation and contamination hazards arose, no personnel suffered injury, ingested radioactive material or received radiation exposures in excess of internationally recommended maximum permissible limits. Furthermore, no danger to the general public arose in any way as a consequence of the incident. (21 references.) (auth)

16292 (RT/ING–(67)14) EXPERIMENTAL BURN-UP PROFILES BY GAMMA SCANNING AND COBALT MONITORING. Pugnetti, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 33p. Dep.

The use of gamma scanning techniques and ^{60}Co activity measurements to determine spent fuel burnup is described. Measured Co wire activities and calculated burnup values are tabulated. A burnup profile for the 6 in. through tube for the ISPRA-1 reactor is obtained. (16 references.) (M.L.S.)

16293 (TRG-Report-1561) CALCULATION OF RELATIVE DISPLACEMENT DAMAGE RATES IN DIFFERING REACTOR TYPES. Birss, I. R. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Aug. 23, 1967. 18p. Dep. CFSTI. UK 3s. 0d.

A number of materials not necessarily destined for use in fast reactors, in which atomic displacements are the main damage mechanism under observation, are presently being irradiated in the Dounreay Fast Reactor. It is shown that if it can be accepted that the ratio of atomic displacement rate in the test reactor to displacement rate in the parent reactor is an acceptable parameter for comparison purposes, then the atomic displacement energy and the electronic cut off energy of a material are not critical parameters in the derivation of this ratio. It is also shown that, if the equivalent fission flux concept is used to describe reactor spectra, it can lead to appreciable errors in deriving the damage ratio, but that integration over the real spectrum is unnecessary below 0.1 MeV. (10 references.) (auth)

16294 (UJV–1905) URCENI NEUTRONOVYCH DAVEK V JADERNYCH REAKTORECH AKTIVACNI METODOU. NAVRH NEUTRONOVYCH INTERGRATORU PRO POUZITI V REAKTORU VVR-S. (Activation Method of Determining Neutron Fluences in Nuclear Reactors. Design of Neutron Flux Integrators for Use in the VVR-S Reactor). Rana, S. B. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct. 1967. 48p. (In Czech). Dep.

A theoretical analysis of the use of foil activation techniques for neutron fluence determinations is given; time dependent flux analyses are given for foil irradiation during constant neutron flux, cyclic change in neutron flux, direct proportionality between neutron flux and reactor thermal power, unknown time dependency of the neutron flux. Reactions suitable to flux integration in the various spectral ranges are discussed. Use of ^{59}Co, ^{63}Cu, and ^{58}Ni at the WWR-S is discussed. 85 references. (M.L.S.)

16295 (UJV–1937) PRECHODOVE PROCESY V EXPERIMENTALNI PLYNEM CHLAZENE REAKTOROVE SMYCCE PRO VYZKUM PALIVOVYCH CLANKU. (The Transient Behavior of Experimental Gas Cooled Reactor Loop for Fuel Element Testing). Pfann, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1967. 61p. (In Czech). Dep.

Steady state and transient processes in a fuel element test loop in an experimental gas cooled reactor are described; the descriptive equations are given. A safety analysis is performed for the loop, assuming reactor shutdown. The computer program, written in ALGOL, which was developed to handle the equations is described briefly. A numerical example of transient processes caused by reactor shutdown because of accident conditions is given. (M.L.S.)

16296 (EURFNR–352) STUDIES AT CHARGE 2 OF THE FAST THERMAL ARGONAUT REACTOR STARK. Barleon, L.; Bayer, A.; Brueckner, Chr.; Burkart, K.; Kuhn, D.; Kussmaul, G.; Meister, H.; Stegemann, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK–592. 116p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

A description of the second core loading of STARK is given. Criticality determinations, neutron flux, and power distribution measurements are described; results are given. Fission rate and fission rate ratios in the fast region are given. Reactivity measurements in the fast and thermal regions are detailed. Pulsed neutron measurements are analyzed; data are presented. 16 references. (M.L.S.)

16297 (JPRS–43924) MODIFICATIONS IN THE CONSTRUCTION AND STUDY OF THE PHYSICAL CHARACTERISTICS OF THE IRT-2000 REACTOR OF THE POWER ENGINEERING INSTITUTE, BELORUSSIAN ACADEMY OF SCIENCES. Borisevich, V. A.; Dolgov, V. M.; Kokhonov, M. F.; Nikolaev, Yu. G.; Orlov, A. S.; Sokol'chik, V. A.; Yaroshevich, O. I. Translation of pp 3-35 from Nekotorye Izmeneniya Konstruktsii i Issledovanie Fizicheskikh Kharakteristik Reaktora IRT-2000 EI, AN, BSSR, Minsk, 1963. 28p. CFSTI.

During the construction of the IRT-2000 reactor, modifications were introduced which considerably expand the experimental potential of IRT-type reactors. The modifications include: installation of an in-pile loop; construction of a second hot cell; inclusion of a gamma irradiation chamber in the fuel storage well; reconstruction of some horizontal experimental channels; and biological shielding improvements. After startup, critical experiments were carried out to obtain data on the physics characteristics and operating parameters of the reactor. (H.D.R.)

16298 (NSJ-tr–93) ANALYSIS OF PHOTONEUTRON FLUX DISTRIBUTION IN WATER-SHIELDED REACTORS. Tagami, Takashi; Kitazume, Mitsuyuki. Translated for Japan Atomic Energy Research Inst., Tokyo, from Nippon Genshiryoku Gakkaishi, 8: 12-15(1966). 9p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

In a water-shielded reactor, the photonuclear reaction γ(d,p)n takes place between γ-rays emitted from reactor core and deuterons contained in the shielding water surrounding the core. Photoneutrons produced by the reaction are distributed in the water layer in addition to the neutrons originated from the core. The distribution of the thermal photoneutron flux in water not close to the core surface is approximated. Comparison of the calculated results to the experiments in BSR-1 shows that the approximation reproduces the photoneutron distribution reasonably well in a region where the neutron flux originated from the reactor core is negligibly small. (M.L.S.)

16299 OPERATIONAL EXPERIENCE IN THE CONTROL OF RADIATION HAZARDS IN THE CANADA–INDIA REACTOR.

Kolhatkar, M. G.; Sharma, A. D.; Somasundaram, S. (Atomic Energy Establishment, Trombay, India). Indian J. Occup. Health, 8: 199-208(1965).

A brief description of the design and construction of the Canada–India reactor is given. The radiation hazards encountered during normal operation and maintenance of the reactor are summarized. The techniques and instruments used in the evaluation of these hazards by means of area radiation surveys and personnel monitoring methods as well as procedures and practices followed for regulating individual exposures to radiation are highlighted. The operational experience in the control of radiation hazards in the reactor is reviewed in the light of the radiation protection guides and standards which have been recommended by the International Commission on Radiological Protection. 11 references. (Indian Sci. Abstr.)

16300 MEASUREMENT OF MATERIAL BUCKLING OF U–H_2O ASSEMBLY. Nakajima, Tadashi; Tojo, Takao; Kondo, Makoto (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 1-6(Jan. 1968).

A method of determining the material buckling of a cylindrical subcritical assembly is described. The new technique is an improved "flux shape" method that is based upon the complete orthogonality of the Bessel function. To obtain sufficient accuracy, a scintillation detector with a very thin scintillator has been used. The result indicates that the present method yields a value of buckling free from higher harmonics and end effects, with a standard deviation of 3.0% under centric point source condition. (auth)

16301 FLUX TILTING IN A TWO-ZONE REACTOR. Jeffers, D. E. (Univ. of Manchester, Eng.); Hall, K. Nucl. Sci. Eng., 31: 358-9(Feb. 1968).

Measurements of flux tilting in a two-zone reactor are described; results are given. A plot of Δk vs flux tilting is shown for the Argonaut-type reactor used. Values determined for the coupling coefficient are given. (M.L.S.)

16302 NUCLEAR REACTORS AS RESEARCH INSTRUMENTS. Walker, J. (Univ. of Birmingham, Eng.). Rep. Progr. Phys., 30: 285-332(1967).

A brief description of the scientific principles of research reactors and of the radiations provided by them is given. The different forms of research reactors, both steady-state and pulsed, with an indication of trends in the design of high flux systems, are described. The internal and external (beam) facilities for experiments are considered, and a number of applications are presented to illustrate the broad scope of possible research. (auth)

16303 ELECTRON PARAMAGNETIC RESONANCE SPECTROMETER FOR NUCLEAR REACTORS. (to Commissariat a l'Energie Atomique). French Patent 1,387,076. Dec. 21, 1964. Filed Oct. 22, 1963.

The installation is used for studying specimens being irradiated in the tangential channel of a nuclear reactor near the core. The installation comprises a solenoid which produces a continuous, stable, and homogeneous magnetic field and a resonant cavity for receiving the specimen to be studied being disposed in the solenoid. A plug and pole system is used for bearing the solenoid. This system comprises a pole for positioning inside the channel and an absorbent plug for closing the entry of the channel. A cooling loop enables a liquid coolant to flow through the solenoid. Electric power supply means are provided for the solenoid and a spectrometer comprising a hyperfrequency source connected to the cavity by wave guide. An electronic detection system receives the resonance signal and transmits the same to an oscilloscope or recording device. (IIB)

16304 ELECTRONIC PARAMAGNETIC RESONANCE SPECTROMETER FOR A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,387,076–(Add. 1). Sept. 12, 1966. Filed May 7, 1965. 1st addition 87,843.

An EPR spectrometer is described to observe during gamma irradiation the formation of defects in the free radicals and lattices in solids, liquids, and gases placed in the resonant cavity. The cooling device is connected to a cooling loop, the spectrometer to the solenoid, and the power supply device to the resonant cavity via a pole. The pole comprises a stationary portion which bears the solenoid, and a moving portion which is normally received in and protected by the stationary portion and which bears the resonant cavity and the feed wave guide. The stationary part of the pole comprises a calorimeter for measuring the gamma-ray flux experienced by the specimen and a hermetic covering containing a concentric tube for guiding the moving part. The moving part comprises a covering whose shape is adapted to the shape of the tube for guiding the stationary part. To prevent gamma radiation from being transmitted through the feed wave guide, it is composed of two long straight parallel sections interconnected by a section at a considerable inclination to the common direction of the other two sections. The covering of the stationary part and the covering of the moving part are partly filled with lead shot for biological shielding. (IIB)

Production Reactors

Refer also to abstracts 15142 and 15738.

16305 DEVICE FOR MONITORING SHUT-DOWN NUCLEAR REACTORS. (to United States Atomic Energy Commission). British Patent 1,097,156. Dec. 29, 1967. Priority date Sept. 17, 1965, United States.

The description of a safeguard instrument to detect reactor operation is presented. The instrument consists of safing wire with a stainless steel enclosure tube; Al pulling strands; a CO target material; and W strands for kinking. (D.C.C.)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 14611, 15135, 15137, 15143, 15153, 15173–15176, 15179, 15181, 15190, 15205, 15225, 15226, 15232, 15243, 15247, 15250, 15267, 15394, 15916, and 15929.

16306 (AERE-R-5601) STABILITY OF FUEL ROD IN A NARROW ANNULAR COOLANT CHANNEL AGAINST THERMAL BUCKLING. Woodrow, J. (Atomic Energy Research Establishment, Harwell (England)). Sept. 25, 1967. 18p. Dep. CFSTI. UK 3s. 0d.

An analysis of the thermal stability of a small transverse distortion of a simply supported fuel rod is given, which can be applied to all but liquid metal coolants. A third order differential equation governing the bowing of the rod is obtained; a transcendental characteristic equation is then found, which enables the critical output of the reactor to be determined without further approximation. Fuel elements which are held rigidly at the upstream end and free at the other end are inherently stable against thermal buckling. (auth)

16307 (BNWL-518) SURVEY OF HYDRAULIC MODELING EXPERIENCE FOR REACTOR CORE SYSTEMS. Hayden, K. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 49p. Dep. CFSTI.

A survey of hydraulic core modeling is presented which includes the following reactors: EBR-2, CP-5, FARET, Piqua, SNAP-8DS, N.S. Savannah, pressurized water reactor, submarine reactors (S1C), SEFOR, FRCTF, HFIR, MPBE, HRT, MSRE, Yankee, Indian Point-Unit 2. The various models are discussed; uses are outlined. (M.L.S.)

16308 (BNWL-640) 2DB: A TWO DIMENSIONAL DIFFUSION-BURNUP CODE FOR FAST REACTOR ANALYSIS. Little, W. W. Jr.; Hardie, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 119p. Dep. CFSTI.

2DB is a two-dimensional (X–Y, R–Z, R–θ), multigroup diffusion code for use in fast reactor criticality and burnup analysis. All programming is in FORTRAN-IV. The code can be used to: compute k_{eff} and perform criticality searches on time absorption (α), reactor composition, and reactor dimensions by means of either a flux or an adjoint model; and compute material depletion rates. Since variable dimensioning is employed, no simple restrictions on problem complexity can be stated. However, in a 65K memory, the current version is nominally restricted to 50 energy groups. Running time (for a k_{eff} calculation) on a UNIVAC 1108 is about 2 minutes for a 30 × 30 mesh problem using 4 energy groups. (auth)

16309 (CEA-R-3351) REPONSE D'UN REACTEUR RAPIDE A UNE SOURCE DE NEUTRONS. (Response of a Fast Reactor to a Neutron Source). Moret-Bailly, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 72p. (In French). Dep.

In the multigroup approximation, a fast homogeneous bare reactor has properties which for each spatial harmonic can be summed up by a matrix A. A classification of reactors is made as a function of this structure which varies with the considered medium. The eigenvalues of A are the decay constants obtained with a pulsed neutron source. In the spectrum of these eigenvalues, is often a marked line related to a fundamental. The line is not always single. The neutron spectrum may be calculated from the eigenvectors. A neutron source, according to its spectrum, excites more or less the various energy harmonics. The detector, for its

part, does not have the same response to all harmonics. Phenomena are symmetrical. Equations of this problem are written in matrix form and applied to sources which can be pulsed, modulated, or controlled by the reactor flux. FORTRAN IV codes for computing the behavior of the detector response are described. Some of these codes use subroutines more accurate than usual ones for computation of eigenvalues and eigenvectors. (auth)

16310 (CEND-300) CETIC: A COMPUTER CODE PACKAGE FOR CALCULATING HEAVY-ISOTOPE CONTENT IN REACTORS FOR USE WITH ISOCHECK METHOD. Kern, Richard; Forbes, Ann; Hencey, Thomas (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). May 5, 1967. Contract AT(38-1)-428. 88p. Dep. CFSTI.

The results of the development of the CETIC computer code package to permit its direct application for calculating the heavy-isotope content in reactors for which the ISOCHECK Method has been set up are presented. The results include: a description of each part of the package along with the equations used to compute the isotopic content; a detailed description of the input and output from each part along with specific examples; and listings of the FORTRAN IV source decks used to compile each part of the package. Sufficient information is supplied to enable correct punching of all cards and to enable the user to make the proper interpretation of all the input data and the available options. (auth)

16311 (CONF-671011–, pp 41-55) SURVEY OF BOILING DETECTION METHODS IN REACTORS. Saxe, R. F. (North Carolina State Univ., Raleigh).

Three principal methods for the detection of boiling in reactors are reviewed. The neutron-flux noise method utilizes a neutron detector and associated equipment to analyze fluctuations of the neutron flux in a reactor. The onset of boiling will be reflected by changes in the neutron flux due to changes in the bubble volume. The ultrasonic probe method utilizes the generation of cavitation by ultrasonic energy at the surface of the probe to determine the state of the liquid. The acoustic emission method depends on the ability to detect the acoustic emission from boiling bubbles. The advantages and disadvantages of the various methods are discussed, and several other techniques under development are mentioned. (H.D.R.)

16312 (CONF-671011–, pp 71-86) APPLICATION OF NOISE ANALYSIS TECHNIQUES TO DETECTION OF INCIPIENT MALFUNCTIONS. Randall, R. L. (Atomics International, Canoga Park, Calif.).

Techniques are described which utilize noise or fluctuation signals from electronic transducers sensitive to vibrations, temperature, power, conductivity, pressure, sound level, flow rate, etc., to detect and study abnormal conditions in reactor systems or test models. Applications which are summarized range from feasibility tests, to development of automatic on-line, incipient malfunction detection systems. Specific phenomena encountered in these applications include: boiling; cavitation; gas entrainment through a reactor core; movement of bubbles through pipes, hydraulic transients; mechanical vibrations; and breakdown of electrical insulators. (auth)

16313 (CONF-671011–, pp 127-62) STRESS-WAVE ANALYSIS TECHNIQUE FOR DETECTION OF INCIPIENT FAILURE. Green, A. T.; Hartbower, C. E. (Aerojet-General Corp., Sacramento, Calif.).

Research has shown that crack growth resulting in a sudden release of elastic energy can be detected by a sensor that converts the elastic wave into an equivalent electrical signal. Thus, this technique is unique as a nondestructive inspection method in that the growing defect in the material transmits its own signal, with the sensor acting as the receiver. The receiving sensors used in these studies and applications have been piezoelectric accelerometers, directly calibrated in engineering units. The Stress-Wave Analysis Technique (SWAT) has been employed as a research tool aimed at learning more about the causes of slow crack growth, particularly as affected by fatigue, hydrogen embrittlement, stress corrosion cracking and spontaneous strain aging. SWAT is now being employed as a field inspection and monitoring process during the pressure qualification testing of rocket motor cases and other pressure vessels. With SWAT one cannot only determine if there is a growing flaw, but can also locate the flaw by triangulation techniques. Moreover, in most structures as the crack increases in length, there is an increase in the rate and amplitude of stress-wave emission that presages failure. (auth)

16314 (EUR-3665) PROGRAMME CIRE. RAPPORT FINAL. (Programme CIRE. Final Report). (Societe Alsthom, Paris (France)). Dec. 1967. Contract 080-66-5 TEEF. 102p. (In French). Dep.

A dynamics code CIRE which can be used to study transients in BWR's resulting from imposed time variations in reactivity introduced by control rod motion or coolant flow, inlet enthalpy, and mean pressure is described. The core is represented by channels in parallel where flow distribution is determined as a function of liquid coolant height, frictional resistances and void distribution in each channel. Finite difference models are used in: treatment of reactor kinetics, calculation of variations of fuel element and can temperature distribution, and determination of heat flux and void distributions. Reactivity feed backs from coolant and fuel temperature as well as void reactivity contribution are determined by integrals over the core volume. Provision is also made for slip ratio and variations of boiling boundary in calculational procedure. Output provides axial distribution of heat flux, void fraction, coolant, fuel, and can temperatures as well as location of boiling boundary in each channel, as functions of time. The code is written in FORTRAN IV for use on the IBM 7094 or IBM 360. (auth)

16315 (GA-7301) A PCPV MODEL: PRESSURE TEST AND EVALUATION. Rockenhauser, W.; Northup, T. E.; Marsh, R. O. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 22, 1966. Contract AT(04-3)-167. 38p. (CONF-670301-2). Dep. CFSTI.

From Prestressed Concrete Pressure Vessel Conference, London, England.

The pressure testing of the first Prestressed Concrete Pressure Vessel model is described. The comparisons of the actual test data with the characteristics and values obtained from the various design and analysis approaches used are presented. The model PCPV was tested hydraulically in a series of increasing pressure cycles to 1720 psig (121 atm), a pressure 3.5 times the hypothetical operating pressure set for the vessel. Results from the pressure tests of the PCPV showed that the state of strain in a PCPV subjected to internal pressure loading can be predicted quite accurately by elastic analysis, if suitable modifications are made to take into account initial inelastic effects. (auth)

16316 (GEAP-5505) ACCURATE NUCLEAR FUEL BURNUP ANALYSIS TWENTY-SECOND QUARTERLY PROGRESS AND FINAL REPORT. Rider, B. F.; Ruiz, C. P.; Peterson, J. P. Jr.; Smith, F. R. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). June 30, 1967. Contract AT(04-3)-189. 56p. Dep. CFSTI.

A five and one-half year program to improve the accuracy of nuclear fuel burnup analysis is summarized. Experimental measurements for the fission yields of ^{137}Cs, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd are given for epithermal fission of ^{235}U, ^{239}Pu, and ^{233}U and for fast fission of ^{238}U. Experimental fission yields are given for ^{133}Cs, ^{137}Cs, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd and ^{150}Nd for thermal fission of ^{241}Pu. A survey and evaluation of published data on thermal fission yields for ^{235}U, ^{239}Pu, ^{233}U, and ^{241}Pu are included. 146 references. (auth)

16317 (HPR-84) THE BURNUP ROUTINE IN THE TRANSPORT CODE: FLEF. Rumpold, A. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). June 1967. 49p. Dep.

The analytical expressions and calculational structure constituting the burnup link of the Swedish multigroup lattice code FLEF are described. The isotopic density equations are solved using a direct analytical method. They describe the fuel cycles starting with ^{232}Th or ^{238}U and take into account nine high cross section fission products and their precursors as well as the aggregate of slowly saturating fission products condensed into twelve pseudo-elements. The changes in the criticality factor of the cell are monitored, and recalculations of the spectrum performed according to criteria set forth in the input. Several possible burn-up modes are optional. (auth)

16318 (UCID-15268) EFFECT OF CORE VOIDS ON SPECIFIC MASS OF REFLECTOR-CONTROLLED REACTORS: IMPLICATIONS FOR CERMET FUELS. Podney, W. N. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 16, 1967. Contract W-7405-eng-48. 43p. Dep. CFSTI.

It has been generally accepted that the largest fuel volume fraction attainable in a reactor design gives the smallest mass per unit power for a reactor system composed of a reactor core, neutron reflector, and shadow shield. It is shown that on the basis of one-energy-group diffusion theory that for reactor systems of the SPR-6 class (50,000 MW-days) the specific mass can be reduced by as much as a factor of two by adding voids to the reactor core. It is then shown that using a cermet fuel to reduce fuel element swelling caused by entrained fission product gases increases the specific mass of such reactor systems. In no case is it reasonable to expect a reduction in specific mass to result from the use of a cermet fuel. (auth)

16319 (UJV-1839) METODIKA TEPELNEHO VYPOCTU TRUBKOVEHO PALIVOVEHO CLANKU S HLADKYM NEBO

ZEBROVANYM POVRCHEM TRUBEK PRO TEZKOVODNI REAKTOR CHLAZENY PLYNEM. (A Method of Thermal Calculations of a Tubular Fuel Element With Smooth or Finned Surfaces for a Gas Cooled Heavy Water Reactor). Halouzka, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1967. 47p. (In Czech). Dep.

A method of thermal calculations of a fuel element consisting of concentric tubes with smooth or longitudinally finned surfaces is described; fins have rectangle form. The aim of the calculation is to determine geometrical parameters of the element, assuming the permissible cladding temperature is attained at all tube surfaces and the outlet temperatures from all annular channels are equal. For the determined geometry of the element certain heat and physical values are calculated and maximum fuel and cladding temperature is checked. The method requires the use of computer and is suitable for fuel element optimization. The programme has been compiled in Gier-Algol; the input tapes and the print of results are described. (16 references.) (auth)

16320 (UJV–1840) VYSLEDKY OPTIMALISACNIHO VYPOCTU ZEBROVANEHO TRUBKOVEHO PALIVOVEHO CLANKU PRO TEZKOVODNI REAKTOR CHLAZENY PLYNEM. (The Results of Optimization Calculations of a Finned Tubular Fuel Element for a Gas Cooled Heavy Water Reactor). Halouzka, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1967. 39p. (In Czech). Dep.

A tubular fuel element with longitudinally finned tubes is described. Fuel element radius, fuel to volume ratio, height of fins, and overall pressure drop along the coolant channel are considered as independent variables. The method of physical calculations is described, while the thermal calculations are carried out according to the method described in report ÚJV Nr. 1839. The results are presented in graphical form. On the basis of this the number of tubes in a fuel element and the extent of influence of the independent variables, which appear to be the optimal ones, are determined. Some selected variations of element design are given. (auth)

16321 (UJV–1876) ROZLOZENI ZDROJU TEPLA V PALIVOVEM CLANKU. (Heat Exchange in Reactor Fuel). Jakab, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1967. 25p. (In Czech). Dep.

The determination of the space distribution of heat sources in the fuel element of a reactor after a consideration of a flattening due to γ-ray absorption and fast neutron fission is discussed. The method may be used for small burn-up fuel elements. Numerical examples are given. 30 references. (auth)

16322 (UJV–1900) SUFFICIENT CONDITIONS FOR THE FLATTENING OF THERMAL NEUTRON FLUX AND SOME RELATED PROBLEMS (IN MULTIDIMENSIONAL GEOMETRIES). Zezula, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sept. 1967. 11p. Dep.

For a prescribed flux of thermal neutrons in the active zone of the reactor the distribution of the fuel concentration in the active zone is to be determined, which induces the given flux in the reactor core. The conditions (in the form of the boundary of the core active zone as well as the boundary of its reflector) are given which are sufficient for a unique solution of the problem and for the special case of flattened thermal neutron flux. The solution is formulated in the two-group diffusion approximation and for multidimensional geometries. (auth)

16323 (UJV–1904) A SUFFICIENT CONDITION FOR THE FLATTENING OF THERMAL NEUTRON FLUX AND SOME RELATED PROBLEMS (IN ONE DIMENSIONAL GEOMETRIES). Zezula, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct. 1967. 14p. Dep.

An expression is derived for the fuel concentration in the active zone of a reactor which induces a given flux in the core. The problem is formulated in the one-dimensional two-group diffusion approximation. A sufficient condition is given for the existence of a unique solution for the equation; the special case of a flattened thermal neutron flux is considered. A method of optimization of total output is described. (M.L.S.)

16324 (WAPD-TM–618(Add.1)) FIGRO (ADDENDUM): A CDC-6600 COMPUTER PROGRAM FOR THE ANALYSIS OF FUEL SWELLING AND CALCULATION OF TEMPERATURE IN BULK-OXIDE CYLINDRICAL FUEL ELEMENTS. LWBR-LSBR Development Program. Waldman, L. A.; Lynn, L. L.; Goldberg, I. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1967. Contract AT(11-1)-Gen-14. 24p. Dep. CFSTI.

The FIGRO computer program calculates internal temperatures and fuel volume swelling in bulk oxide cylindrical fuel elements. The addition of a model of interfacial heat transfer, which includes conduction through a physical gap whose size is determined by fuel and clad differential thermal expansion and by fuel swelling is presented. In addition, the thermal conductivity of the clad is computed as a function of temperature, and that of the fuel-clad gap as a function of temperature and gas composition. The new version is in production on the CDC-6600 computer. (auth)

16325 (WAPD-TM–736) COMBINED SPACE–TIME SYNTHESIS WITH AXIALLY DISCONTINUOUS TRIAL FUNCTIONS. LWBR-LSBR Development Program. Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1967. Contract AT(11-1)-Gen-14. 71p. Dep. CFSTI.

A synthesis approximation model is developed for the solution of detailed three-dimensional space-time group diffusion problems. The proposed method uses two-dimensional spatial trial functions that exhibit a step-wise discontinuous behavior in the axial dimension. This feature permits switching of trial functions at specified axial locations. An explicit treatment of movable fuel regions is incorporated into the model. The synthesis equations are derived and a detailed description of the calculation of the necessary integrals and matrix elements is presented. Static numerical examples are presented which illustrate the selection of trial functions and the potential accuracy of the combined space-time synthesis model. 14 references. (auth)

16326 (WCAP–3677-6) FRACTURE MECHANICS EVALUATION OF REACTOR VESSEL STEELS. Quarterly Progress Report for the Period Ending December 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Jan. 1968. Contract AT(30-1)-3677. 18p. (EURAEC–1953). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The experimental program for the development and evaluation of a fracture mechanics approach to the problem of brittle fracture of reactor vessel materials, based upon the use of modified Wedge Opening Loading (WOL) specimens, is described. The testing applies to both irradiated and unirradiated specimens. Materials being tested include base metal samples from two different heats of a Ni modified, Mn–Mo steel and a European forging grade material; and weld and heat affected zone samples from one of a Ni modified, Mn–Mo steel. Tensile, Charpy V-notch and drop weight specimens from those materials are included. (auth)

16327 (ANL-Trans–558) A THERMOMECHANICAL CORE ANALYSIS "DANGER SPOTS" AND "PLASTIC FUEL." Karsten, G. Translated by Elmar K. Wilip (Argonne National Lab., Ill.) from Paper BE/4-Notiz nr. 72. 21p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

A formula for calculation of the maximum burnup of a fuel element is analyzed. The formula is based on the assumption that the maximum burnup is attained when all the pore volume and empty volume in the fabricated element has been filled. The assumption was made that these volumes are displaceable over the entire element. An assumption that there is a serious interaction between the fuel and the cladding under conditions of uneven burnup leads to the conclusion that "danger spots" are produced in the half of the core where the coolant inlet is located. (H.D.R.)

16328 APPLICATION OF SYNTHESIS TECHNIQUES TO THE CALCULATIONS OF THREE-DIMENSIONAL REACTIVITY-COEFFICIENT DISTRIBUTIONS. Bear, J. L.; Judge, F. D.; Venerus, E. R. (General Electric Co., Schenectady, N. Y.). Contract W-31-109-eng-52. Nucl. Sci. Eng., 31: 349-53(Feb. 1968). (KAPL-P–3312).

Application of synthesis techniques to calculation of three dimensional reactivity coefficients is discussed. An expression using this synthesis method is formulated. Comparisons between synthesized calculations and diffusion theory calculations are presented graphically. (M.L.S.)

16329 ANOMALIES ARISING FROM THE USE OF ADJOINT WEIGHTING IN A COLLAPSED GROUP-SPACE SYNTHESIS MODEL. Yasinsky, J. B.; Kaplan, S. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 31: 354-8 (Feb. 1968).

The use of the adjoint weighting procedure, as used in a collapsed group-space synthesis model, is discussed. Test problems are used to show how use of weighted adjoints destroys the utility of this collapsed-group synthesis. The use of adjoint weighting techniques is compared to use of Galerkin weighting. (M.L.S.)

16330 REVIEWS OF STATUS OF TECHNOLOGY OF FAST REACTOR FUELS. Zebroski, E. L. (General Electric Co., San Jose, Calif.); Kittel, Howard; Moss, DeWitt. pp 2.63-80 of Fast Reactors National Topical Meeting, San Francisco, California, April 10–12, 1967. Hinsdale, Ill., American Nuclear Society, 1967.

See CONF-670413–(and Suppl.).

A review of the development of fast-reactor fuels is given. The U–Pu fuels are of three types: mixed oxides, mixed carbides,

and U–Pu–M ternary alloys (where M is Zr or Ti). Fast and thermal neutron irradiation effects on the mixed oxide fuels are tabulated; swelling rates are shown. Powder fuels development and fabrication are discussed briefly. Studies on compatibility between fuel and cladding and carbide fuel element design are outlined; carbide fuel performance is reviewed. Development of U–Pu alloys are discussed; fuel fabrication and performance are reviewed. The status of fast reactor fuel irradiations in EBR-II is tabulated. 20 references. (M.L.S.)

16331 HYDROGEN TRANSPORT INTO POROUS BEDS OF ZIRCONIUM HYDRIDE AS A MECHANISM OF NUCLEAR REACTOR CONTROL. Lightner, Ralph Gabriel. College Park, Md., Univ. of Maryland, 1967. 113p.

Thesis.

The transport of hydrogen into porous beds of zirconium hydride particles is considered as a possible mechanism for controlling the reactivity of a nuclear reactor. It is concluded, on the basis of experiment and analysis, that the process warrants serious consideration. Graphical and tabular data giving the equilibrium pressure-temperature-composition relationship, the phase diagram, diffusion coefficients, density, heat capacity and thermal conductivity of zirconium hydride are collected. Hydrogen was transported from one bed of zirconium hydride particles to another by a thermally induced pressure gradient. An analytical model was developed and experimental flows were compared with predicted values. Actual flows were found to exceed predictions in most cases. An average deviation of −29.6% from the measured flows was obtained. It is hypothesized that nonequilibrium conditions at the initiation of the transient resulted in this discrepancy. The mathematical model is evaluated for a range of conditions which might be considered for use in a hydrogen transport reactor control system. It is shown that for a given void fraction of bed there is a single effective particle size which will allow hydrogen absorption into the bed at a maximum rate. Smaller particles impose larger delays because they present increased resistance to gas flow. Larger particles have larger diffusion paths and therefore impose larger delays. (TSS) (Disser. Abstr.)

16332 SPACER FOR FUEL ASSEMBLIES. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,100,706. Jan. 24, 1968. Priority date June 3, 1964, Sweden.

A description of spacing devices for reactor fuel element assemblies is presented. The fuel assembly consists of parallel circular rods in a square lattice configuration. The spacer body is made of tubular elements surrounding the fuel rods and spacer springs between the spacing elements and fuel rods. (D.C.C.)

16333 SUPPORT SYSTEM FOR A FUEL ELEMENT. Dmitrieff, Anatole (to Commissariat a l'Energie Atomique). British Patent 1,100,087. Jan. 24, 1968. Priority date Oct. 28, 1965, France.

A reactor fuel element support system is described which consists of a metal can with radially extending longitudinal centering partitions. Low-neutron-absorption support bars are connected to the partitions parallel to the axis of the fuel element. The bars are rigidly interconnected by two metal members which are located one at each end of the bars. The bar configuration consists of four graphite rods placed symmetrically on two perpendicular axes. (D.C.C.)

16334 FUEL BUNDLE SLEEVE OF A NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,097,902. Jan. 3, 1968. Priority date May 13, 1964, Germany.

The description of a fuel bundle sleeve for a nuclear reactor is presented. The sleeve is made of a brittle material with reinforcing ties. The ties are arranged in helices or parts of helices winding around the axis of the sleeve or arranged parallel to the axis of the sleeve. The ties are secured at each end of the sleeve by rings. (D.C.C.)

16335 PRESSURISED NUCLEAR REACTOR INSTALLATIONS. Johnson, Frank Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,100,625. Jan. 24, 1968. Filed Dec. 8, 1964.

The description of a pressurized-water reactor containment system is presented. The containment consists of two vessels with one vessel enclosed in the second vessel. The liquid-filled vessels have non-return pressure vents with the first vessel vented to the bottom of the second vessel. The second containment vessel contains electric generating equipment and is gas vented to the atmosphere. (D.C.C.)

16336 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CORE COMPONENTS. Evans, Paul Bernard Francis; Burton, Eric John (to United Kingdom Atomic Energy Authority). British Patent 1,100,555. Jan. 24, 1968. Filed July 20, 1964.

The description of a sound regulated pressurized fluid flow device is presented. The system consists of two compartments separated by a whistle orifice. The first compartment provides pressurized fluid for reactor operation and has a limiting plug of fusible material. The second compartment contains the fuel element. Fluid flow through the orifice produces a sound which is detected and converted into electrical response control. (D.C.C.)

16337 CONTROL VALVE SYSTEM IN A NUCLEAR POWER INSTALLATION. (to Licentia Patent Verwaltungs-GmbH). British Patent 1,096,265. Dec. 20, 1967. Priority date Mar. 20, 1964, Germany.

The description of a control valve system for a steam pipe connection to a turbine is presented. The steam pipe includes a cut-off valve which is mounted with a by-pass valve on a common spindle. The valves are operated by a common drive so that the by-pass valve is opened when the cut-off valve is closed to allow the steam which still flows into the pipe to discharge into a condenser. The valve system consists of valves connected by a common spindle which is moved by a hydraulic motor. (D.C.C.)

16338 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,100,767. Jan. 24, 1968. Priority date Aug. 27, 1964, Luxembourg.

A method is described for controlling the reactivity of a reactor by circulating a volatile neutron absorbing solution through the core. A portion of the solution is fed from the primary circuit to a distillation apparatus and the distillate vapor is washed out in a column with liquid from the primary circuit. The washed out neutron absorbing solution in the column is collected in a chamber and returned to the primary circuit through an adjustable valve or recycled through the distillation apparatus. (H.D.R.)

16339 BURST NUCLEAR FUEL ELEMENT DETECTION. Kealy, Wellesley Ashe (to United Kingdom Atomic Energy Authority). British Patent 1,100,723. Jan. 24, 1968. Filed July 6, 1964.

The burst can detection system consists of a fuel element can containing a space with a ferromagnetic signal member supported by internally pressurized capsules. The space is pressurized sufficiently to compress the capsules and hold the signal member in a fixed position. In the event of can failure, the capsules expand and the corresponding movement of the signal member is indicated by detection means external to the fuel element. (H.D.R.)

16340 FISSION PRODUCT VENTING SYSTEM FOR A NUCLEAR REACTOR. Costes, Didier; Ferrari, Giorgio (to Commissariat a l'Energie Atomique). British Patent 1,097,160. Dec. 29, 1967. Priority date Nov. 23, 1965, France.

The venting system for each reactor fuel element comprises a gas collection chamber supported by the fuel element and a vent line with a shut-off valve. For a cluster of elements, a circuit connects the vent lines to a fission product receiving station outside the reactor vessel. The connecting circuit is provided with a closure by means of pressurized inert gas. The venting system is especially applicable to reactors cooled by water, liquid metal, or organic liquid. (H.D.R.)

16341 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Campion, Peter (to United Kingdom Atomic Energy Authority). British Patent 1,102,764. Feb. 7, 1968. Filed Apr. 2, 1965.

A purification process for CO_2 coolant gas is presented. The contaminated gas is passed over a CuO catalyst bed in the presence of O_2 to completely oxidize the contaminants present. The gas is then passed over an active Cu metal catalyst bed in the presence of CO to form CO_2. (D.C.C.)

16342 IMPROVEMENTS IN LIQUID-COOLED, LIQUID-MODERATED NUCLEAR REACTORS. Worley, Norman George (to Babcock and Wilcox Ltd.). British Patent 1,102,422. Feb. 7, 1968. Filed Feb. 24, 1965.

A description of a liquid-cooled, liquid-moderated reactor is presented. The reactor consists of a core, a main heat exchanger, and a circuit through which primary coolant is passed through the core and the main heat exchanger. The circuit also contains removable auxiliary best exchanger for trapping radioactive deposits from the 520°F operating primary coolant. (D.C.C.)

16343 ABSORBER ROD FOR NUCLEAR REACTORS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,102,235. Feb. 7, 1968. Priority date June 9, 1964, Sweden.

A description of a neutron-absorber rod for nuclear reactors is presented. The control rod consists of four fan-type blades at right angles to each other connected to a central support axis. The blades have limited freedom of movement around the longitudinal

axis. The absorber blades are connected to the central support by their ends, and they also fit into longitudinal grooves in the central support body. (D.C.C.)

16344 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR SAFETY ROD ACTUATORS. Winders, Gordon Robert (to Babcock and Wilcox Co.). British Patent 1,102,255. Feb. 7, 1968. Priority date May 1, 1964, United States.

A description of a reactor control rod actuator system is presented. The actuator is comprised of a piston working in a cylinder which relies on fluid pressure to hold the control rod withdrawn above the reactor core. The actuator is located beneath the core. A coolant pressure drop causes the control rod to be lowered in the actuator cylinder. The cylinder is designed with fluid outlets for excessive pressure in the fluid. The cylinder has a diminishing diameter extension for retarding the piston movement at the end of insertion. (D.C.C.)

16345 STEAM GENERATOR ADAPTED TO BE HEATED BY REACTOR WATER FROM A NUCLEAR REACTOR. (to AB Rosenblads Patenter). British Patent 1,102,288. Feb. 7, 1968. Priority date Oct. 14, 1964, Sweden.

A description of a steam generator is presented. The generator consists of a closed vertical vessel with a boiling space above an upper tube wall, a heat space beneath a lower tube wall, and an inlet and an outlet chamber for the reactor water between the tube walls. Two separate pipe line systems provide a water supply to the main heating element in the boiling space and to a subsidiary heating element in the heating space. (D.C.C.)

16346 IMPROVED SYSTEM FOR ELIMINATING THERMAL SHOCKS IN NUCLEAR REACTORS. (to Skoda, Narodni Podnik). British Patent 1,100,298. Jan. 24, 1968. Priority date Jan. 3, 1965, Czechoslovakia.

A description of a system for eliminating thermal shocks in a nuclear reactor is presented. The system consists of a thermal accumulator in the form of a grid or grating placed in the coolant flow channel following core passage. (D.C.C.)

GENERAL

16347 (AE-307) SOLUTION OF LARGE SYSTEMS OF LINEAR EQUATIONS WITH QUADRATIC OR NON-QUADRATIC MATRICES AND DECONVOLUTION OF SPECTRA. Nygaard, K. (Aktiebolaget Atomenergi, Stockholm (Sweden)). 1967. 15p. Dep.

A new method is described for deconvolution of spectra. It is done numerically and is equivalent to the solving of a system of linear equations with square of non-square matrices. (SWEDEN)

16348 (ANL-7396) ARGONNE NATIONAL LABORATORY PUBLICATIONS, JULY 1, 1966-JUNE 30, 1967. (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 372p. Dep. CFSTI.

A bibliography is presented of scientific and technical accounts originated at Argonne and published during the fiscal year 1967 (July 1, 1966 through June 30, 1967). It includes items published as journal articles, technical reports, books, etc., all of which have been made available to the public. Author and KWOC (keyword out of context) indexes are included. (B.G.D.)

16349 (BM-RI-7077) PERFORMANCE OF OPEN-CIRCUIT SELF-CONTAINED BREATHING APPARATUS AT -25° F. Kloos, E. J.; Raymond, L. D.; Spinetti, L. (Bureau of Mines, Pittsburgh, Pa.). Feb. 1968. 16p.

Bureau of Mines-approved self-contained breathing apparatus of the compressed air demand type were evaluated for performanc at low temperature. Apparatus durations, breathing resistances, and airflow rates were measured on machine tests at room temperature and -25° F. Man tests under actual wearing conditions verified the machine test results. Many serious functional changes in apparatus performance occurred at low temperature. Pressure regulators malfunctioned when diaphragms lost flexibility. Under certain conditions frozen condensed moisture sealed exhalation valves and fogged eyepieces. High-pressure leaks, not encountered at ordinary temperature, developed at low temperature. Test results are discussed generally and specifically for each apparatus. Recommendations are given to obtain optimum performance from demand type breathing apparatus at low temperatures. (auth)

16350 (BNL-50057) ANNUAL REPORT, JULY 1, 1967. (Brookhaven National Lab., Upton, N. Y.). Nov. 1967. Contract AT(30-2)-Gen-16. 228p. Dep. CFSTI.

A separate abstract was prepared for each of the 8 sections presented. (W.H.K.)

For abstracts of individual sections see: 14513, 14869, 14870, 14905, 14906, 15141, 15659, and 15873.

16351 (BNWL-538) THE PACIFIC NORTHWEST LABORATORY HYBRID COMPUTER SYSTEM. Erickson, M. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 60p. Dep. CFSTI.

A hybrid computer system was developed by interfacing a Beckman Model 2133 analog computer with a Digital Equipment Corporation PDP-7 digital computer. The interface includes a 24 channel multiplexer, a high speed analog-to-digital converter, and 24 high speed digital-to-analog converters. Control interface circuits enable the digital computer to direct all hybrid functions. The hybrid computer system has been used in the simulation and control system development for the Fast Flux Test Facility. (auth)

16352 (COO-614-59) ICR QUARTERLY REPORT NUMBER 15. Yngve, Victor H. (Chicago Univ., Ill. Inst. for Computer Research). Nov. 1, 1967. Contract AT(11-1)-614. 103p. Dep. CFSTI.

Developments in computer and computer programming research are briefly reported. Topics discussed include the Man-Machine project, a user's view of capabilities, simplified implementations of the EOL language, symmetrical stacks in EOL, and the UNCLLL Plex-Processing language. Also, signal-to-noise ratio in fringe visibility measurements with a michelson stellar interferometer and a scheme for studying astronomical "seeing" are described. (W.H.K.)

16353 (GAMD-8362) GRAFIX: A COMPUTER PROGRAM FOR THE VISUAL DISPLAY OF ENGINEERING DATA. Doering, D. A. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 13, 1967. Contract AT(04-3)-167. 100p. Dep. CFSTI.

GRAFIX is a general-purpose Univac 1108 computer plot code. The code uses the GA Plot Package and RITE Package to generate a Stromberg Carlson SC-4020 CRT plotter control tape for off-line processing. It is designed to give the user considerable flexibility and ease in preparing customary engineering graphs and figures of reasonably high quality from data stored on card, tape, or drum. By option control, the user can vary the size and type of scales, grids, and titles; plot symbols; draw solid or dashed curves with or without arrow heads; label individual curves; overlay plots; annotate; draw figures; and subdivide a given frame into subframes to generate larger plots in sections. Processing time is less than 2 seconds per frame. (auth)

16354 (GEPP-8) ROTATING SAMPLE HOLDER FOR X-RAY EMISSION SPECTROMETER. Quebbeman, N. P.; Jones, C. W. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). Dec. 29, 1967. Contract AT(29-2)-656. 15p. (R-67-ND-5). Dep. CFSTI.

A rotating sample holder for x-ray emission analysis of nonhomogeneous samples provides more reliable x-ray emission data by averaging nonhomogeneous irregularities from different sample areas that are observed continuously. The rotating sample holder described was designed and constructed for use on a General Electric XRD-6 x-ray emission spectrometer. Detailed drawings of the sample holder are given. X-ray intensity variation obtained by using the sample holder for continuous sample rotation shows a significant improvement in overall precision when compared to intensity variation obtained by rotation only between readings. Other advantages of using the rotating sample holder are considered. (auth)

16355 (IN-1159) VERSATILE SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF MICROGRAM AMOUNTS OF MERCURY. Fullerton, F.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Jan. 1968. Contract AT-(10-1)-1230. 22p. Dep. CFSTI.

A method is presented for the determination of mercury in a variety of inorganic and organic samples. After selected pretreatments, the mercury dithizonate complex is extracted from an EDTA-citrate medium into chloroform, the absorbance of which is measured at 495 mμ. The effects of 35 metal ions and 8 nonmetal anions were studied. Only silver (I) interferes at less than a 50 to 1 molar ratio. (auth)

16356 (KR-116) SURVEY OF ACTIVITIES, 1966. Aabakken, Bjarne (ed.) (Institutt for Atomenergi, Kjeller (Norway)). Mar. 1967. 134p. Dep.

Research progress is reported under the following topics: reactor dynamics, power reactor studies, marine reactor studies, engineering development, reactor physics, digital and analog computers, reactors, neutron physics, K-1 fuel reprocessing project, radiochemistry, operation of the waste treatment plant, reactor chemistry, analysis, UO_2 metallurgy, fuel element development and fabrication, material techniques and testing, K-4 corrosion project, isotope production and development, the Netherlands-Norwegian Reactor School, safety work, and health physics. (M.C.G.)

16357 (LA-DC-8931) THE MANIAC II SYSTEM. Lazarus, Roger; Wells, Mark; Wooten, John Jr. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 12p. (CONF-670834-1). Dep. CFSTI.

From Computing Machinery Symposium, New York, N. Y.

The primary goal of this system is to provide the scientist-computer intimacy necessary for effective use of the MANIAC II computer as a research tool. Since communication is from a single console, this is not a time-shared system, although much of what we do resembles a sophisticated (hence expensive) remote-station operation. The chief means of conversation are a paper tape reader and a full keyboard scripting Flexowriter; sense lights, dials, magnetic tapes, a card reader, a scope with light-pen, and a line printer are also available. The system is based on use of a 7 million word, fast-access disk. This disk contains user source and object programs (each user is assigned about 40,000 words for his private use), as well as system codes: a job-sequencer (supervisor), a compiler (Madcap), a source program editor, subroutines, and various debugging aids. Request for a job (or sequence of jobs) is made via the Flexowriter in a conversational mode. In many cases, jobs require no input except from the Flexowriter and the disk. (auth)

16358 (NYO-1480-85) A SYNTAX-DIRECTED FORTRAN STATEMENT CHECKER. Hoffberg, Susan S.; Goldstein, Max (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Jan. 1968. Contract AT(30-1)-1480. 54p. Dep. CFSTI.

A syntax checking program for analyzing a given line of FORTRAN coding for grammatical correctness is described. Included are the flow diagrams, the syntax specification table, and a listing of the code for the syntax checker. (W.H.K.)

16359 (NYO-2133-48) ENTHALPIMETRIC ANALYSIS. Jordan, Joseph; Carr, Peter W. (Pennsylvania State Univ., University Park. Dept. of Chemistry). Dec. 14, 1967. Contract AT(30-1)-2133. 6p. (CONF-680404-1). Dep. CFSTI.

For Presentation at 155th Symposium on Analytical Calorimetry, San Francisco, Calif.

Two calorimetric methods, thermometric enthalpy titration (TET) and direct injection enthalpimetry (DIE), are described. Both TET and DIE are ideally suited to the needs of organic functional group analysis. The limitations imposed by TET are: the heat of reaction must be large enough to produce an accurately measureable temperature change (0.01°C) in as short a time as possible, at the most 3 min; the heat of dilution of the titrant must be small as compared to the heat of reaction; and the titration curve should be controlled solely by equilibria and not by the rate of any slow chemical reaction. The first two limitations apply to DIE as well, but the kinetic limitation is not so severe since a large excess of reagent may be added to increase the overall reaction rate. At best, TET is capable of an accuracy and precision of 0.2 to 0.5% whereas DIE is best utilized when a precision of 3 to 5% is acceptable at millimolar concentration levels. The precision and accuracy of the two methods depends upon both heat of reaction and concentration. A method of obtaining useful analytical results in situations where the titration curve is significantly distorted by kinetics was developed. (D.H.M.)

16360 (NYO-3685-13) RESEARCH ON BUOYANT PLUMES. Annual Report, 1967. (Waterloo Univ. (Ontario). Dept. of Mechanical Engineering). Jan. 1968. Contract AT(30-1)-3685. 120p. Dep. CFSTI.

Full-scale plume rise studies were performed at the Lakeview (Toronto) power station. New experimental equipment and techniques employed are described including an experimental but reliable method for obtaining the lapse rate at heights of 2000 ft in moderate to high winds. A kite was designed to lift a tethersonde. The kite maintains the sonde at a steady height even in gusty winds. Results obtained describe the behavior of the chimney plumes under all stable conditions. Completed full-scale observations are described. Laboratory simulation of thermals provide information on buoyant motion. Observations of model plumes observed in Western Ontario's large wind tunnel were completed and described a theoretical explanation of the complex actual behavior of plumes in a stable or unstable atmosphere is given. The need for an experimental investigation of the fluctuation problem in atmospheric distribution is described. (F.S.)

16361 (ORNL-TM-1629) COST STUDY OF THE TREATMENT OF SEWAGE SLUDGE BY THE WET-AIR OXIDATION PROCESS, USING OXYGEN PRODUCED BY LOW-COST ELECTRICITY FROM LARGE NUCLEAR REACTORS. Schaffer, W. F. Jr. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A preliminary economic survey was made to determine what cost benefits could be achieved from the integration of industrial and urban waste-treatment facilities using low-cost electricity. Recent studies predicted that low-cost nuclear power might be produced at about 1.6 mills/kwhr. This cost study is an investigation of the use of oxygen instead of air in the wet-air oxidation (Zimmermann) process for the disposal of sewage sludge. Oxygen produced by conventional air liquefaction processes is estimated to cost $4.03 and $5.64 per ton for a 1200-ton/day plant when electricity is supplied at 1.6 and 5.0 mills/kwhr respectively. The cost of sewage sludge treatment was studied as a function of oxygen costs with oxygen priced from $2 to $6.15 per ton. The calculated savings over using air varied from 24.9 to 5.9% for large municipal disposal plants operating with a load of about 1000 tons of sludge per day. (auth)

16362 (ORNL-TM-2110) EVALUATION OF MAXIMUM LIKELIHOOD ESTIMATES OF PARAMETERS IN MIXTURES OF NORMAL DISTRIBUTIONS. Gosslee, D. G.; Bowman, K. O. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 22p. Dep. CFSTI.

Data from experiments have been analyzed by the method of maximum likelihood for mixtures of two, three, four, and five distributions. An analytic procedure is used to evaluate the estimates for mixtures of two distributions, and a Monte Carlo procedure is used for mixtures of more than two distributions. Preliminary evaluation of the method by Monte Carlo studies for mixtures of three distributions with equal variances indicates that the method is valid within the degree of mixture typical of the distribution of DNA content of megakaryocyte cells. (W.H.K.)

16363 (ORO-2840-4) ROTATION AND DEBYE RELAXATION SPECTRA OF DIPOLAR COMPOUNDS IN THE MICROWAVE REGION. Final Report, March 1, 1961–October 31, 1967. Kadaba, Prasad K. (Kentucky Univ., Lexington. Research Foundation). Dec. 13, 1967. Contract AT(40-1)-2840. 26p. Dep. CFSTI.

Apparatus was set up to measure the dielectric constant ϵ' and the loss ϵ'' in liquid, solid, and gas phases. A coaxial dielectric cell and a 3-terminal liquid cell were constructed. The real and imaginary parts of the dielectric constants of some alkyl amines were measured in the solid phase. The dielectric constant and loss factor of the binary mixtures of benzonitrile and propionitrile were measured and the data analyzed in terms of two partly superimposed Debye regions The dielectric constant and loss factor of mixtures of benzonitrile with acetonitrile were measured. A systematic study of the loss factor versus frequency of pure chloroform was undertaken. At 30°C, the dielectric constant and loss of aniline, O-chloroaniline, and anisole were measured. The dispersion and absorption of microwave radiation by $CClF_3$, CHF_3, $CHClF_2$, COS, CF_4, and C_2ClF_5 were measured to calculate effective collision diameters. (M.C.G.)

16364 (SC-CR-67-2752) OPTIMUM SAMPLING METHODS. Final Report. Breipohl, Arthur M.; Hooker, John C.; McCormick, William C. Jr. (Oklahoma State Univ., Stillwater. School of Electrical Engineering). Aug. 1967. Contract 55-5520 (B). 108p. Dep. CFSTI.

For Sandia Corp. [Albuquerque, N. Mex.].

A method of modeling a time varying population is described. This allows construction of an optimum sampling size that can be described by decision theory formulation. The modeling method suggests a way of incorporating the results of component tests and variables information to predict degradation. It is suggested that the sequential sampling method may be useful in production acceptance sampling. The FORTRAN program is given; sample inputs and outputs are shown. (9 references.) (M.L.S.)

16365 (SC-CR-67-2862) OPTIMIZATION STUDY OF CIRCUIT CARD DESIGN. Ulrich, John; Ulrich, Laura Cameron (Thomas Bede Foundation, Los Altos, Calif.). Dec. 1967. Contract 72-3058. 64p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

An optimization study to continue on the now well defined problem of circuit card etching layout was undertaken as a theoretical study which would be ideally suited for digital (i.e., noninteracting by mutual inductance, etc.) components. It involves a heuristic logic that is valid and optimum for independent components with no lead length problems; but would not be valid for high frequency analog circuits. The study was verified by computer programs. (auth)

16366 (SC-DC-67-2054) NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION BY THE MATRIX DISPLACEMENT METHOD. Stricklin, James A.; Haisler, Walter E. (Texas Agricultural and Mechanical Univ., College Station); MacDougall, Hugh R. (Sandia Corp., Albuquerque, N. Mex.); Stebbins, Fredrick J. (National Aeronautics and Space Administration, Houston, Tex. Manned Spacecraft Center). Aug. 1967. Contracts AT(29-1)-789; 82-8874. 11p. (CONF-680101-2). Dep. CFSTI.

From AIAA 6th Aerospace Sciences Meeting, New York.

A method is presented for the nonlinear (large deflection) analysis of shells of revolution with both symmetrical and asymmetrical loadings. The efficiency and accuracy of the resulting numerical program make it of practical as well as theoretical value. (auth)

16367 (SC-DC-67-2295) DIFFERENCES BETWEEN THE COMBUSTION OF ALUMINUM DROPLETS IN AIR AND IN AN OXYGEN–ARGON MIXTURE. Prentice, J. L. (Naval Weapons Center, China Lake, Calif. Michelson Labs.); Nelson, L. S. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 13p. (CONF-671035-1). Dep. CFSTI.

From Western States Section Fall Meeting, Seattle, Wash.

When aluminum droplets were burned in air and its nitrogen-free analog, 20% O_2 in Ar, marked differences between the combustions appeared. The freely falling aluminum droplets were formed and ignited with single millisecond pulses from a Nd glass laser. Trajectories of aluminum droplets burning in air indicated vigorous spinning and showed jetting and fragmentation in the lower portion of the trace. In the nitrogen-free combustion, the trace was broader and somewhat shorter. The trace showed no sign of a spinning particle. The droplet that burned in 20% O_2–Ar fell considerably more slowly than the droplet that burned in air, and virtually stopped before extinguishment. When the droplets were allowed to impact glass plates at similar stages of combustion, marked differences again appeared. The droplet burned in the O_2–Ar mixture was a bare aluminum sphere surrounded by a circular smoke pattern. The droplet ignited in air showed a glass-like hemispherical cap attached to one side of the aluminum sphere and the smoke pattern was nonsymmetric. (M.C.G.)

16368 (SC-DC-67-3204) EVALUATION OF THICK QUARTZ DISK (TQD) TRANSDUCERS. Activity Report,

July 5–August 31, 1967. Duggin, B. W. (Sandia Corp., Albuquerque, N. Mex.). Contract AT(29-1)-789. 45p. Dep. CFSTI.

The evaluation of thick quartz disk (TQD) transducers was made to determine the feasibility of using TQD's to measure short rise time, high intensity shock pulses encountered in shock tube tests. (B.G.D.)

16369 (SC-TM-68-4) THE QUANTITATIVE DETERMINATION OF LEAD, CADMIUM, AND INDIUM IN URINE IN MICROGRAM AMOUNTS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Torres, Frank (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. Contract AT(29-1)-789. 20p. Dep. CFSTI.

The metals are isolated and concentrated using an ion exchange resin. They are then selectively eluted and quantitated using the atomic absorption spectrophotometer. (auth)

16370 (TID-24249) THE PATTERN ARTICULATION UNIT OF ILLIAC III: HOMOGENEOUS BOOLEAN FUNCTIONS IN THE ITERATIVE ARRAY. Report No. 253. McCormick, Bruce H.; Watson, William J.; Borovec, Richard T. (Illinois Univ., Urbana. Dept. of Computer Science). Jan. 8, 1968. Contract AT(11-1)-1018. 23p. Dep. CFSTI.

The Pattern Articulation Unit (PAU) of the Illiac III Computer is a modular parallel data processor for visual information. The internal data word is a plane having dimensions 32 × 32 bits. Planes are processed in parallel by the execution of homogeneous (plane-wide) operations. This processing is performed in an Iterative Array having an internal storage capacity of 9 planes. These 9 planes of fast registers, which in many ways serve as multiple accumulators, are augmented by 48 planes of core storage, the Transfer Memory of the PAU. The homogeneous Boolean functions evaluated in the Iterative Array, and the machine language whereby instructions for homogeneous Boolean functions are transmitted to the PAU are described. (auth)

16371 (UCRL-13335) OPEN AND CLOSED-LOOP TECHNIQUES FOR COMPUTER CONTROLLED INSTRUMENTATION. Final Report. Brubaker, T. A. (California Univ., [Livermore]. Lawrence Radiation Lab.). Jan. 20, 1968. Contract W-7405-eng-48. 12p. Dep. CFSTI.

Results of investigations on time domain synthesis of finite memory digital filters, time domain synthesis of infinite memory digital filters, discrete state spece techniques in real time digital simulation, the effects of round-off errors in small computer implementation of finite memory filters, discrete Fourier transforms, adaptive sampling and quantization, and decision theory for data analysis are given. (B.G.D.)

16372 (UCRL-17814) PUZZLE: A PROGRAM FOR COMPUTER-AIDED DESIGN OF PRINTED-CIRCUIT ARTWORK. Zane, Ronald; Wilber, Deanna A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 12, 1967. Contract W-7405-eng-48. 5p. (CONF-680106-3). Dep. CFSTI.

From International Conference on System Sciences, Honolulu, Hawaii.

A program developed to aid in the solution of the topological problems encountered in printed-circuit artwork design is described. It is emphasized that the program is intended as a tool for use by the designer to reduce the human effort required to produce both the topological solution and the graphic output needed for the manufacture of etched printed circuit boards. A method of describing the location of individual pads and a library of modular components is discussed. The program is intended to have maximum use in the area of two-sided printed-circuit boards for integrated circuits. It is also possible to design discrete component circuits with the existing version of the program. (auth)

16373 (UCRL-70706) ELECTRONIC CIRCUIT DESIGN USING COMPUTERS. Magnuson, Waldo G. Jr.; Kuo, Franklin F. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 4p. (CONF-680106-2). Dep. CFSTI.

From International Conference on System Sciences, Honolulu, Hawaii.

The requirements imposed for the effective use of computer analysis programs in electronic circuit design include a consideration of the design method, the computer system, the engineer–computer interface, and the analysis programs themselves. The above requirements are examined by describing the design loop, by comparing time-sharing with batch processing, by discussing graphical communication with an analysis program, and finally it makes some general comments regarding computer-aided electronic circuit design. With the development of more effective on-line, graphical consoles and the design of network analysis programs tailored for this environment, the computer-aided design loop will be closed and a more effective means of design be realized. (auth)

16374 (UCRL-70794) OPACITY OF SMOKES FROM CERTAIN WOODS AND PLASTICS UNDER SMOLDERING AND BURNING CONDITIONS. Gaskill, James R.; Veith, Charles R. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 28, 1967. Contract W-7405-eng-48. 10p. (CONF-680305-1). Dep. CFSTI.

For Presentation at Symposium on the Flammability Characteristics of Polymers, San Francisco, Calif.

Work is being carried out to develop an acceptable test system to determine the opacity and toxicity of products evolved from smoldering or burning materials. A smoke chamber was built; it consists of an 18 ft^3 metal sample holder, a vertical path light source and phototube system, and an exhaust fan. The opacity of smokes from a number of woods and plastics was determined. (M.C.G.)

16375 (UR-49-891) ACUTE FLUORIDE TOXICITY: PLASMA FLUORIDE CONCENTRATIONS FOLLOWING ACUTE ORAL DOSES OF SODIUM FLUORIDE IN THE RABBIT. Hall, Larry Lee (Rochester Univ., N. Y. School of Medicine and Dentistry). 1967. Contract W-7401-eng-49. 115p. Dep. CFSTI.

Thesis.

Three methods for the determination of fluoride in biological samples were investigated. The method of Singer and Armstrong (1965) was rejected because of inconsistent results. The procedure of Wharton (1962) was successfully employed but was rejected because the measurement of the native fluoride differed by a factor of four when compared with the results of the analysis performed by the method of Smith and Gardner (1951). The method of Taves (1966) was adopted since the results with this method were of the same order of magnitude as those of Smith and Gardner (1951) when analyzing the same sample. The 24 hour LD_{50} of NaF given orally to 2kg female rabbits was calculated to be 135 mg/kg by the method of Litchfield and Wilcoxon (1949) with 95% confidence interval of 120 to 152 mg NaF/kg. Female rabbits weighing 2kg were given fluoride (100 to 140 mg NaF/kg) by stomach tube and blood samples were taken at intervals up to 24 hours. The peak plasma fluoride concentration occurred in 30 to 120 min, average 60 min. Those rabbits whose maximal plasma fluoride concentrations exceeded 25 ppM expired and those in which the concentration remained below this level usually survived. In only two cases where the plasma level did not exceed 25 ppM did exitus occur, and these animals maintained concentrations of approximately 18 ppM until death (after 6 and 8 hours). The clearance of fluoride from the plasma at these doses displayed a half-time of approximately four hours although moderate scatter of the data occurred at the various time intervals. No difference could be discerned between the plasma clearances of those animals that died and those that expired. The results suggest that the response is the effect of the total amount of fluoride that is related to the plasma concentration and the time during which the concentration is elevated. Despite apparently normal clearance of these integrated doses the animals expired. The value of this threshold amount remains to be elucidated. The results of this study delineate at least partially another parameter in the toxicity of sodium fluoride in mammals, viz. a threshold level of plasma fluoride associated with death. (auth)

16376 (LA-tr-67-106) CONDENSATION PRODUCTS OF FURFURYL ALCOHOL. II. PRODUCTS FROM EARLY STAGE FURFURYL ALCOHOL CONDENSATION WITH AN ACID CATALYST. Takano, K. Translated for Los Alamos Scientific Lab., N. Mex., from Nippon Kagaku Zasshi, 79: 955-8(1958). 10p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Condensates from the early stage condensation of furfuryl alcohol using a HCl catalyst were isolated and the condensation mechanism investigated. The main constituent of the early stage condensates is believed to be a long chain polymer that is produced by consecutive condensations of furfuryl alcohol. It was found that at least part of the difurylmethane in the condensation product was produced by diphenyl ether that formed first from a condensation between 2 molecules of furfuryl alcohol and then by a split-off of formaldehyde. A part of the once released formaldehyde was found to recombine with the furan ring. It was also found that 2-hydroxymethyl-5-furfuryl furan is crystalline and that difurfuryl ether, similar to difurylmethane, forms good crystalline mercuric chloride compounds. (auth)

16377 ELECTRIC PROPULSION: SYSTEMS, FLIGHT MECHANICS, POWER SOURCE, AND MISSION APPLICATIONS. Stuhlinger, Ernst (National Aeronautics and Space Administration, Huntsville, Ala.). pp 540-625 of Nuclear, Thermal, and Electric Rocket Propulsion: Fundamentals, Systems, and Appli-

cations. Willaume, R. A.; Jaumotte, A.; Bussard, R. W. New York, Gordon and Breach, Science Publishers, Inc., 1967.

Discussions are presented on the following: (1) history of electric propulsion, (2) classification of electric propulsion systems, (3) flight mechanics, (4) rocket motion in central gravity field, (5) the ion motor, (6) electric space power sources, and (7) missions for electrically propelled space vehicles. (M.O.W.)

16378 VACUUM ULTRAVIOLET SPECTROMETER (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1672).
26 drawings.

A vacuum ultraviolet spectrometer is described which is used to study auroral ultraviolet radiation in the spectrum 1100 to 1600 Å. The spectrometer was launched with a filter wheel photometer and an electron spectrometer in a 12 in. dia payload on a Nike–Tomahawk rocket. The spectrometer survived the temperature, acceleration, and spin environment of the rocket and operated under pressures of 10^{-3} to 10^{-7} torr. Resolution is less than 10 Å. (For details see TID-4100 Suppl 44.) (F.S.)

16379 CONTROLLED-POTENTIAL D.C. POLAROGRAPH-VOLTAMMETER /Q-2792/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1652).
2 drawings.

A versatile, reliable polarograph designed to possess all the capabilities of previous instruments, and to have improved performance, additional functional and operational features, and the low maintenance requirements resulting from the use of solid-state operational amplifiers is described. Scan rates from 0.1 volt per minute to 10 volts per minute are available. Efficient averaging of signal fluctuations caused by a dropping-mercury electrode is accomplished by plug-in filter modules. This permits accurate first and second time derivatives of the signal to be taken. Both derivative outputs are calibrated. The cell potential, taken from a voltage follower connected to the reference electrode, is presented on the X axis of an X-Y recorder. The cell current or one of the various functions of the cell current appears on the Y axis of the recorder. Extremely reproducible polarograms can be recorded at 1.0 volt per minute with a 0.5-second controlled drop time. First derivative polarograms are reproduced to 0.2% of full scale on the recorder and are recorded in approximately 25 seconds. (For details see TID-4100 Suppl. 43.) (TSS)

16380 POLAROGRAPHIC DROP TIME CONTROLLER /Q-2942/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1651).
13 drawings.

An apparatus is described which provides precision control of the drop time of the dropping Hg electrode used in polarography. The apparatus operates with different capillaries over long periods of time without requiring mechanical or electrical adjustment. Drop times from 0.25 to 10 sec are provided. Oscillographic photographs of current-time curves indicate that no significant distortion of the diffusion current occurs at drop times of 0.25 sec or longer. At drop times shorter than 0.25 sec reproducible drops are achieved but some distortion of the current-time curve occurs. Drop times are reproduced with a precision of 0.01% with the controller, which is a factor of 10 better than the precision attained with a free-falling drop. Use of the apparatus increases the precision that can be attained in polarographic analysis and allows high sensitivity to be achieved without selection of capillaries. (For details see TID-4100 Suppl. 43.) (TSS)